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TECHNICAL REPORT NO. 10002

DETAIL SURVEY of RIVERINE ENVIRONMENT

March 1967

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by

D. M. Lassaline
D. A. Sloss
W. J. Baker
C. X. C. F. Miranda

The University of Detroit
Department of Civil Engineering

For
Land Locomotion Division
Contract No. DA-20-113-AMC-09099 (T)

TACOM

MOBILITY SYSTEMS LABORATORY

U.S. ARMY TANK-AUTOMOTIVE COMMAND Warren, Michigan

20040204 158

Technical Report No. 10002

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Detroit, Michigan 48221

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ABSTRACT

A survey was made along the Black and the Huron Rivers in southern Michigan to determine the character and magnitude of the riverine environment. This was a pilot study to assess the feasibility of intensive riverine surveys, significant factors, and methods to collect the data. Eighty-two sites were surveyed.

Survey data concerning

1. Cross-sections
2. Soil properties and strengths
3. Vegetation characteristics
4. Conditions along the channel bottom

is included in the report. Methods for gathering the data, types of data gathered, analysis, conclusions, and recommendations for future survey techniques are discussed.

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ACKNOWLEDGEMENT

The following individuals made up the field crew responsible for the river cross-section survey and soil strength measurements:

Gene Cassel
Lester Faremouth
Thaworn Jayagupta (Immediate Field Supervisor)
Douglas Kierdorf
Stanley Nosal
Chang Pang-Ting
Paul Stokes

Mr. Arthur Radford prepared the Vegetation Survey and assisted in the preparation of the figures.

Mr. Lawrence Janowiak of the University of Detroit assisted in the preparation of the figures.

Mr. Robert Krutilla of the U. S. Hydrologic Survey, Lansing, Michigan supplied the hydrologic records used for Appendix B.

The work and cheerful cooperation of all these individuals is gratefully acknowledged.

FOREWORD

Summary

Previous studies developed a general knowledge of the riverine environment in the United States. The objective was to determine what was there. The intensive study of two Michigan rivers was intended to provide some information on the water depth changed during the year so that a statistical representation of the riverine environment could be established. An additional use of the survey data was to establish exit window frequency for the two rivers.

Findings

1. Relevant data on the riverine environment can be collected in an expedient manner using the survey techniques developed by the survey.

2. Fifty-nine percent of the river banks surveyed on the Black and Huron rivers were estimated to be negotiable by a M-113 Armored Personnel Carrier.

3. Gaging station data for the two rivers showed that the water level remains approximately constant for from 48 to 50 weeks during the year, with high water occurring a total of only two to four weeks.

4. The two rivers differed markedly in the relative changes in water level during the year. The Black river had sudden changes in water level whereas the Huron had more moderate changes. The average rainfall for both areas was approximately the same.

5. The Black river was found to be predominately in a "natural" state with no provisions for flood control. Approximately twenty-five percent of the Huron river environ has been "built up" with structures, such as dams, for flood control.

Conclusions

1. The Black and Huron rivers have frequently occurring exit windows.

2. Water levels higher than those measured during the survey could be expected for a total of from two to four weeks during the year.

3. In order to make predictions of the river depths in an area, it will be necessary to know the type and extent of flood control measures being used as these effectively control the depth and change of water level irrespective of rainfall.

Recommendations

1. A study should be initiated to determine the practicality of predicting river magnitude and geometric form (plan and cross-section).

2. Additional surveys should be made to establish the exit window frequency on various types of rivers.

LIST OF FIGURES

LIST OF FIGURES
(continued)

I. INTRODUCTION

The purpose of this study was to develop methods of conducting a detailed survey of a river and to provide comprehensive information on at least two riverine environments for further analysis.

Previous studies (Lassaline 1967, Sloss 1967) established that river frequency was about one river every 14 to 14.5 miles in the Eastern United States. Subsequent analysis of the data from these surveys showed that for about 25 percent of the rivers surveyed the river width, depth, velocity and exiting would present a river crossing problem, and that for an additional 50 percent of the rivers the bank alone would represent a severe exiting problem for existing military vehicles (Sloss 1967).

The two factors missing from previous studies were:

a. A description of a river along its entire length.
b. A description of the change in river width and depth with the seasons of the year.

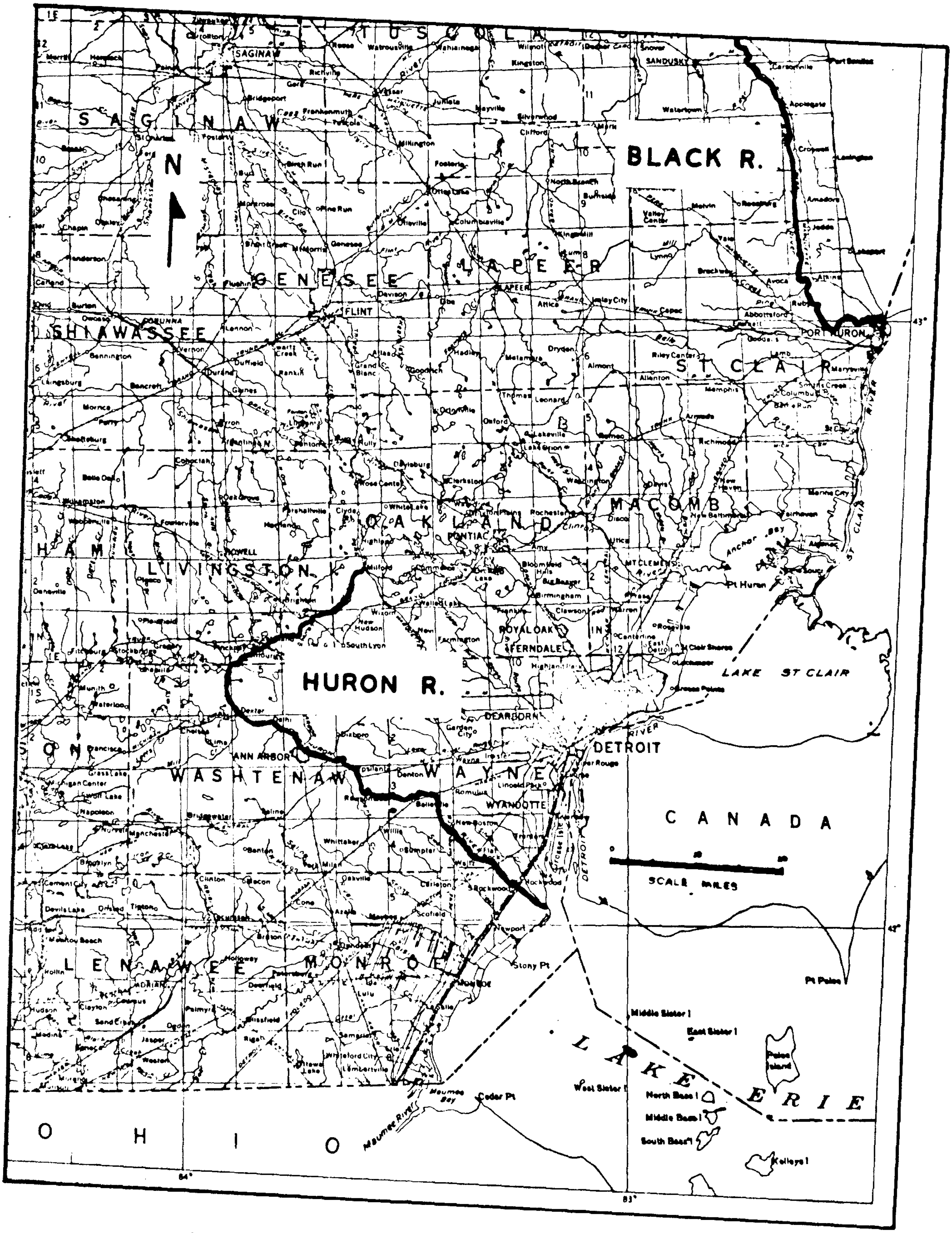
Previous surveys concerned random, isolated, river cross-sections, measured at the time of the survey (usually late summer or fall). The objective of this study was, therefore, to provide a more complete picture of the total riverine environment and to attempt to assess how this environment changes during the year.

II. AREAS SURVEYED

The Black and Huron Rivers were selected for the pilot survey because they are the most significant streams in southeastern Michigan, averaging 75 to 100 feet in width, are readily accessible, and are free from safety hazards created by pollutants. The location of the rivers is shown in Figure 1.

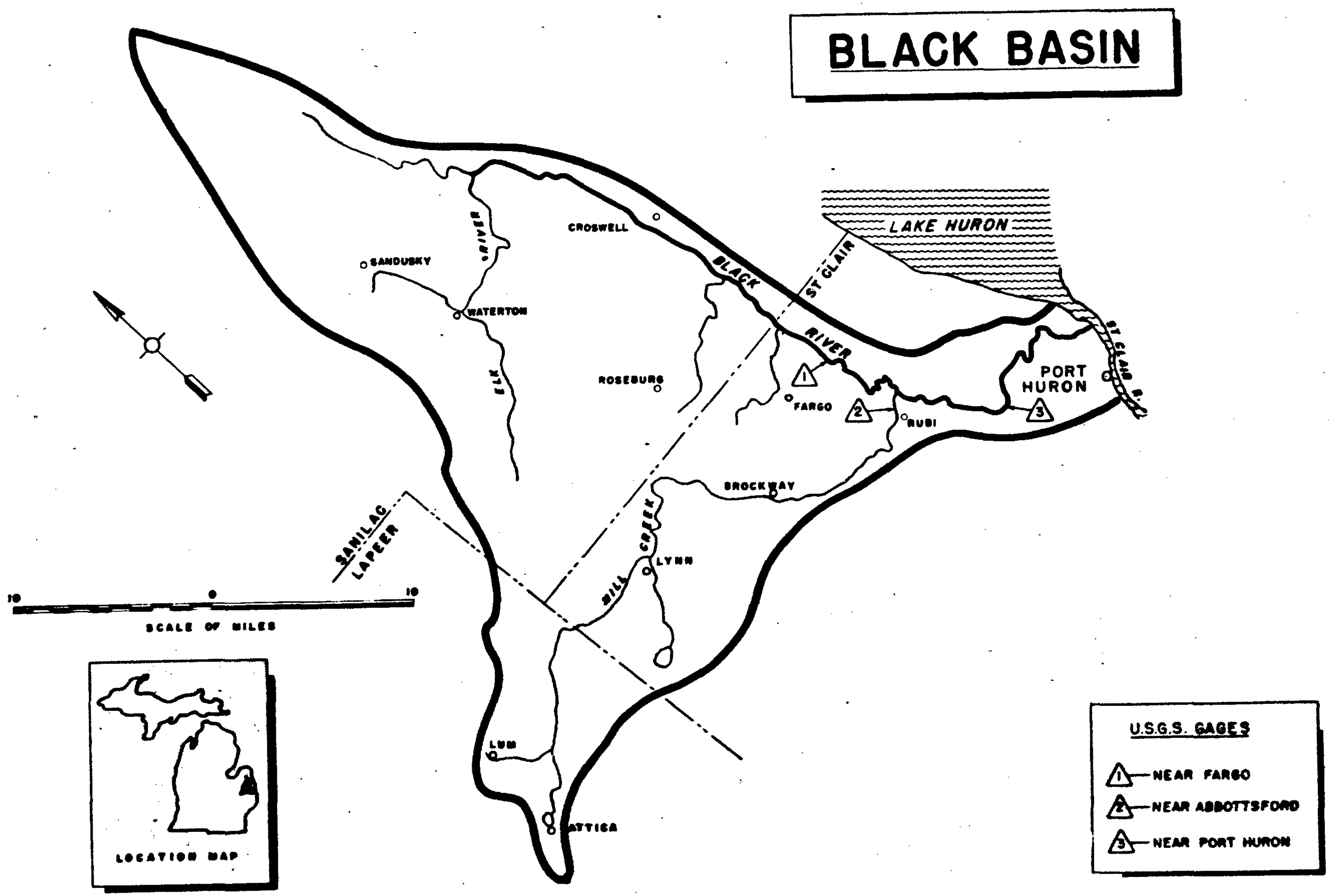
A. Black River.

The Black River is located about 50 miles to the north of Detroit in the "Thumb" area of Michigan (Figure 2). The headwaters are in Sanilac



SURVEY AREA — SOUTHEASTERN MICHIGAN

Figure 1.



ref: "Drought Flow of Michigan Streams", p.608

BLACK RIVER BASIN

Figure 2

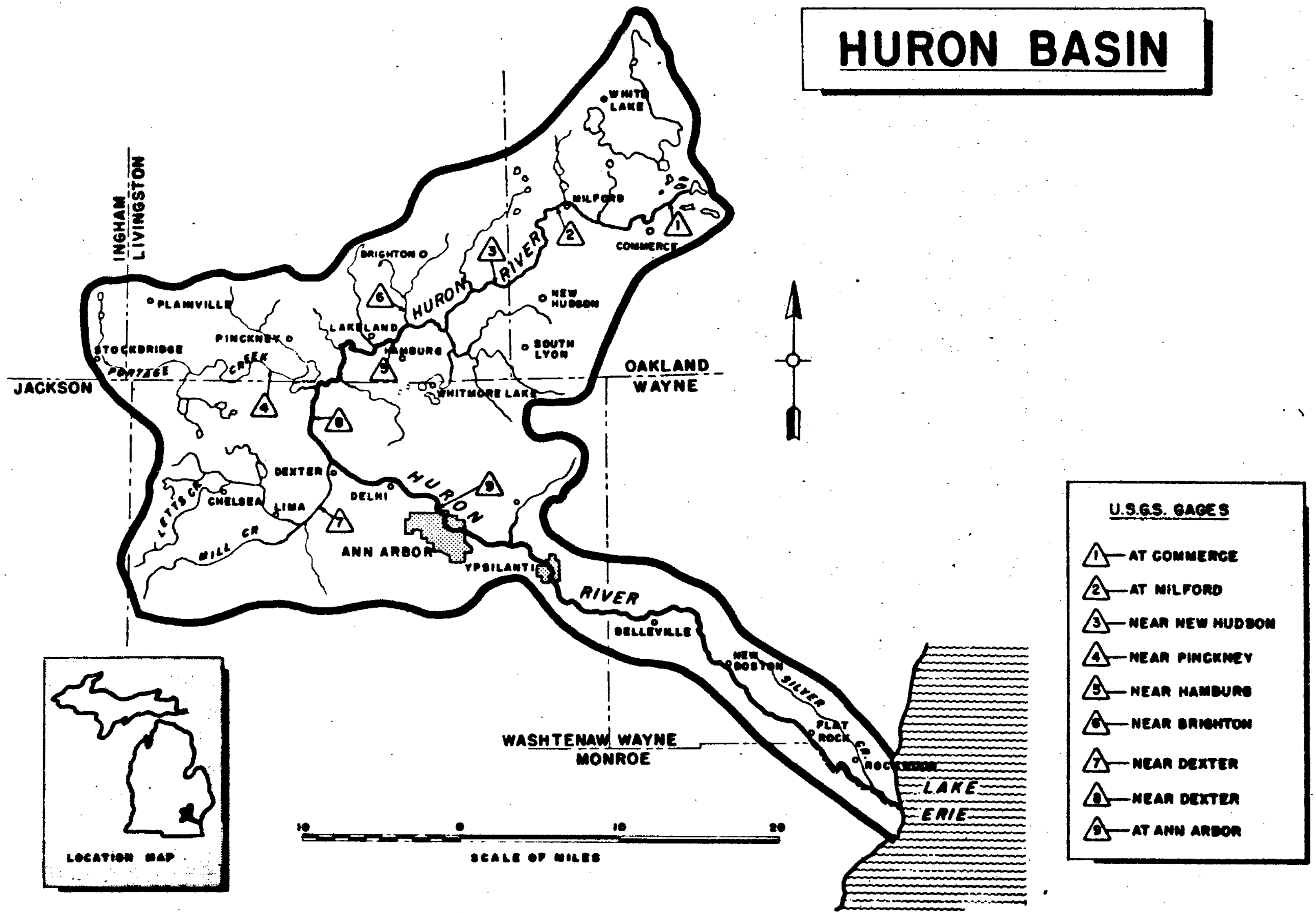
County and the stream flows in a generally southern direction through St. Clair County until it turns to the east and empties into the St. Clair River. The drainage area of the Black River is about 475 square miles and the length is about 60 miles. Crops and pasture are the principal land uses in the basin (USDA Survey, 1929). In a few places, the river backlands have been converted to recreation areas but, agricultural uses largely occupy the land extending to the banks.

The Black River Basin area is under a Humid Continental climate, with precipitation all through the year with an average annual precipitation level of about 25 - 30 inches. The geology of the area is dominated by continental glaciation. The topography is mostly flat or gently rolling. In general, the Black River becomes more deeply entrenched as it flows southward. The flood plains are rather narrow in comparison to the valley of the Huron River. There are few streams in the area and much of the land is artificially drained.

The soils of St. Clair County are predominantly heavy textured, consisting of silt loams and loams. Imperfectly - to poorly - drained soils cover about 80 percent of the area. This condition is in large part due to the largely impermeable, clayey subsoils which lower infiltration and increase runoff. The original forest cover consisted of oak, beech, maple, and basswood, with some scattered stands of conifers. Vegetation near poorly drained areas may consist of elm, ash, aspen, tamarack, and willow.

B. Huron River.

The Huron River Basin is located about 40 miles to the west of Detroit, Michigan (Figure 3). The headwaters are in Oakland County and the stream flows in a generally south to southeast direction through Livingston, Washtenaw, Wayne, and Monroe counties, and empties into Lake Erie. The drainage area of the Huron River is about 700 square miles and the length is about 65 miles (USDA Survey, 1930). Crops and pasture are the principal land uses in the basin. The backlands of the streams are forested or have been converted to recreation purposes.



ref: "Drought Flow of Michigan Streams", p.654

HURON RIVER BASIN

Figure 3

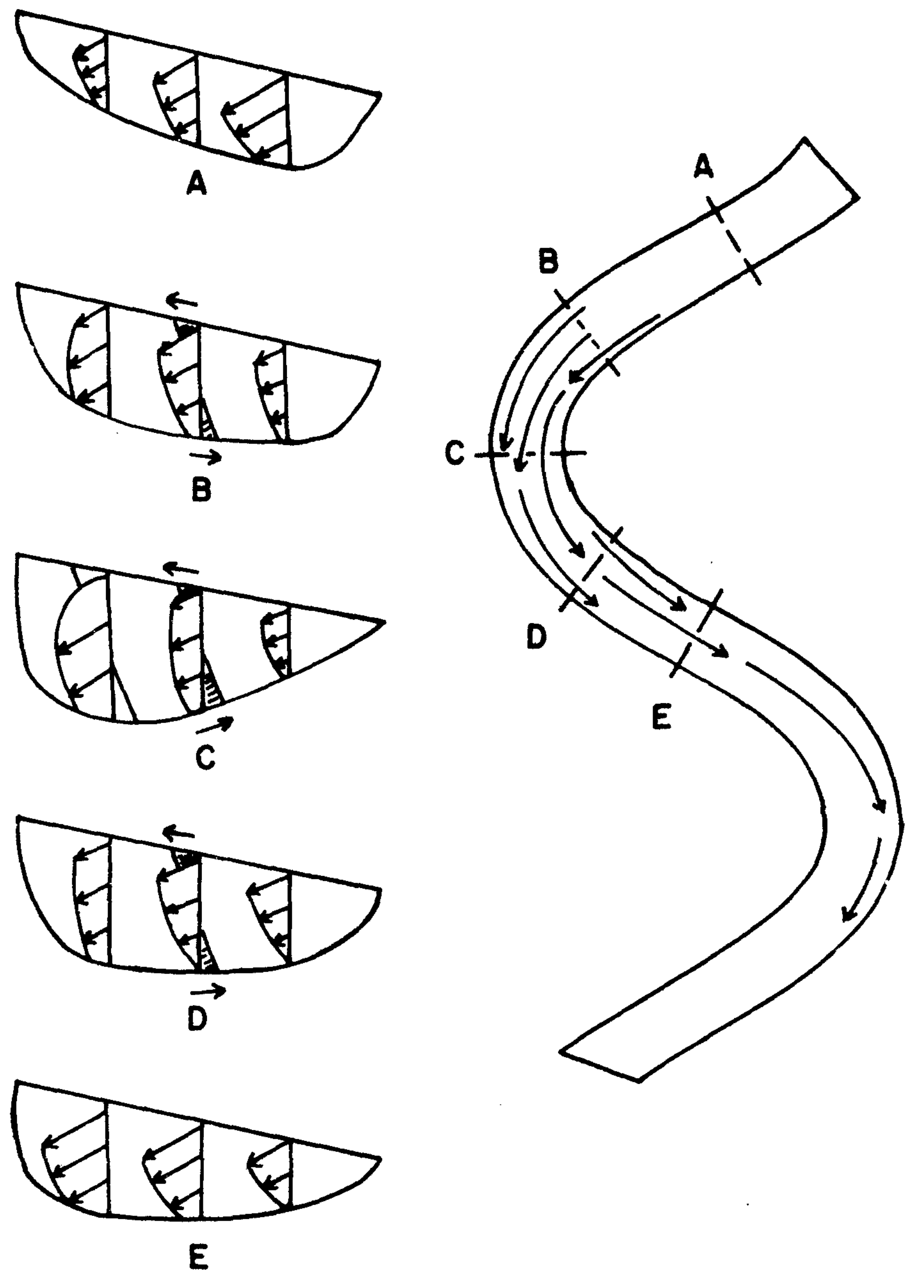
The Huron River Basin area is under a Humid Continental climate, with precipitation all through the year and an average annual precipitation level of about 25 - 30 inches. The geology of the area is characterized by continental glaciation. The northern half of the Huron River is located in an end moraine characterized by low ridges, knobs (kames), and associated depressions. The southern half of the Huron River is located in the Erie Lowland, a glacial lake plain, which is relatively flat compared to the end moraine to the north. The Huron River is characterized by a broad and flat valley.

In general, the drainage is disorganized, a characteristic of areas of recent continental glaciation. The tributary streams are small, eccentric in direction, and originate in lakes and swamps. The stream characteristics are strongly influenced by local topography created by the character and trend of the glacial features. Swamps, marshes, and similar poorly drained areas are quite common.

The soils in the upland end moraine are predominately sandy and/or gravelly loams. The lake plain soils are generally clayey and silty. About three-quarters of the soils can be considered adequately drained. The natural vegetation, now largely cleared, is predominately composed of hardwoods. Some of the most common species are maple, willow, sycamore, beech, ash, tulip tree, wild cherry and elm. Tamarack and willow are among the small trees commonly found near the poorly drained areas.

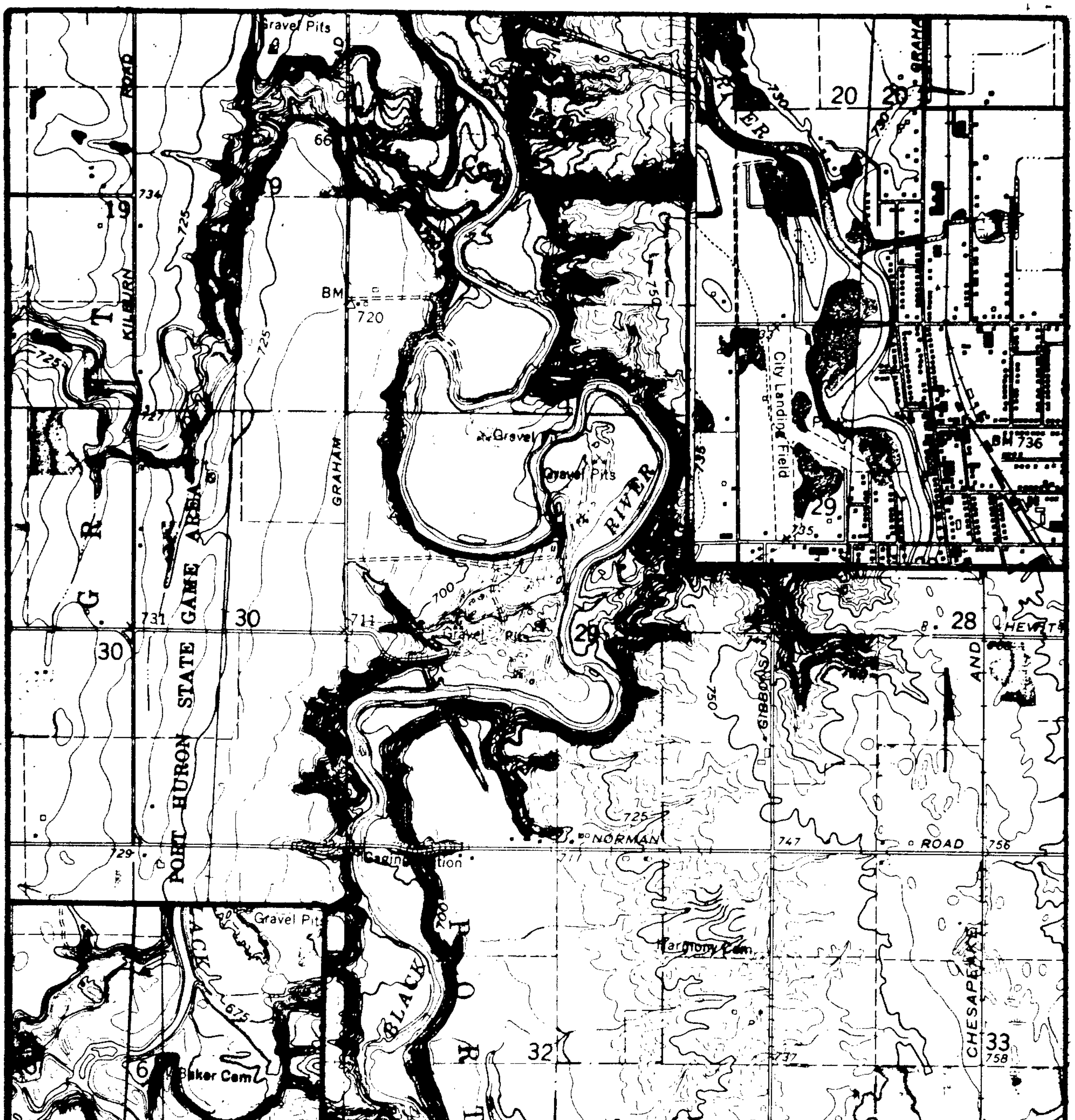
III. PILOT TEST PROGRAM AND DATA COLLECTION PROCEDURES

Sites were chosen on the basis of previous analysis showing that the full range of stream cross sections could be expected along a river meander. A stream rarely runs in a straight line for a distance more than 10 times its width, and a meander is defined by sine-generated curves with a defined radius of curvature and wave length (Leopold 1966). The maximum stream velocity varies from a central position at the upstream portion of the meander to offset positions at the center and downstream portions of the meander (Figure 4). This change in the velocity profile produces a corresponding change in the river profile because of the erosion-deposition process. Figures 5 through 10 show the topography of the test areas and location of the test sites.



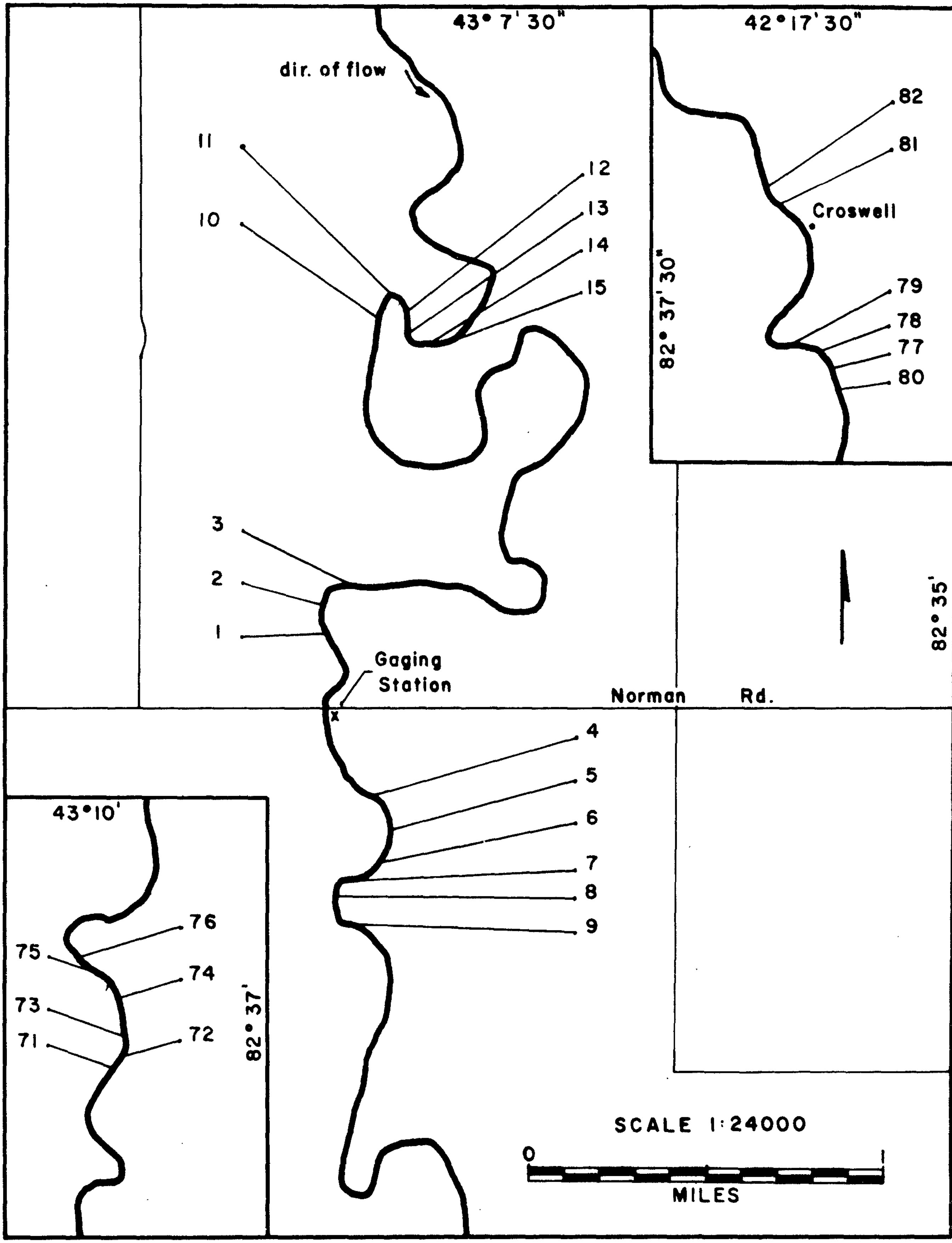
IDEALIZED FLOW PATTERN AND CROSS SECTIONS IN A TYPICAL MEANDER (Leopold 1966)

Figure 4



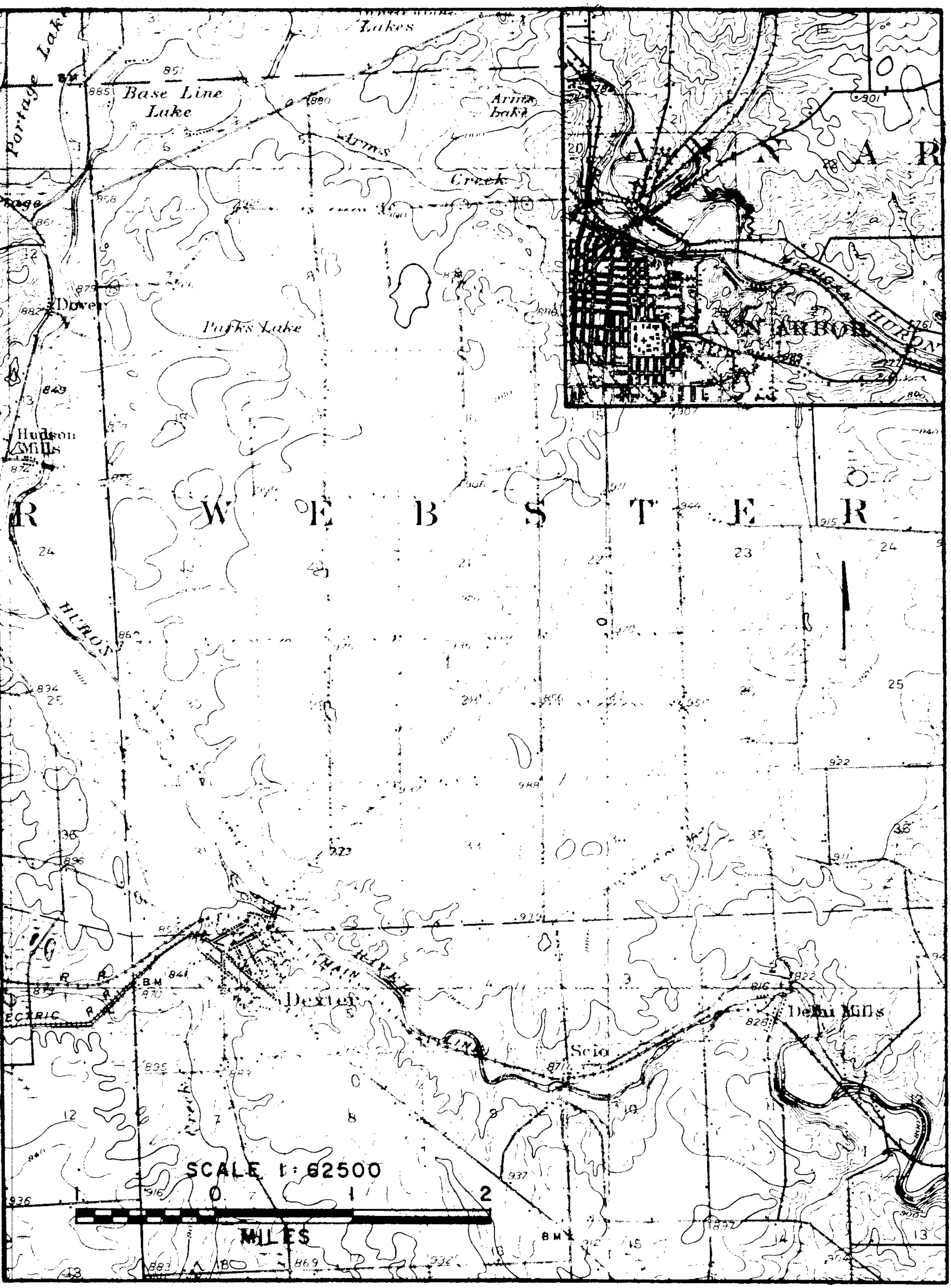
TOPOGRAPHY - BLACK RIVER AREA

Figure 5



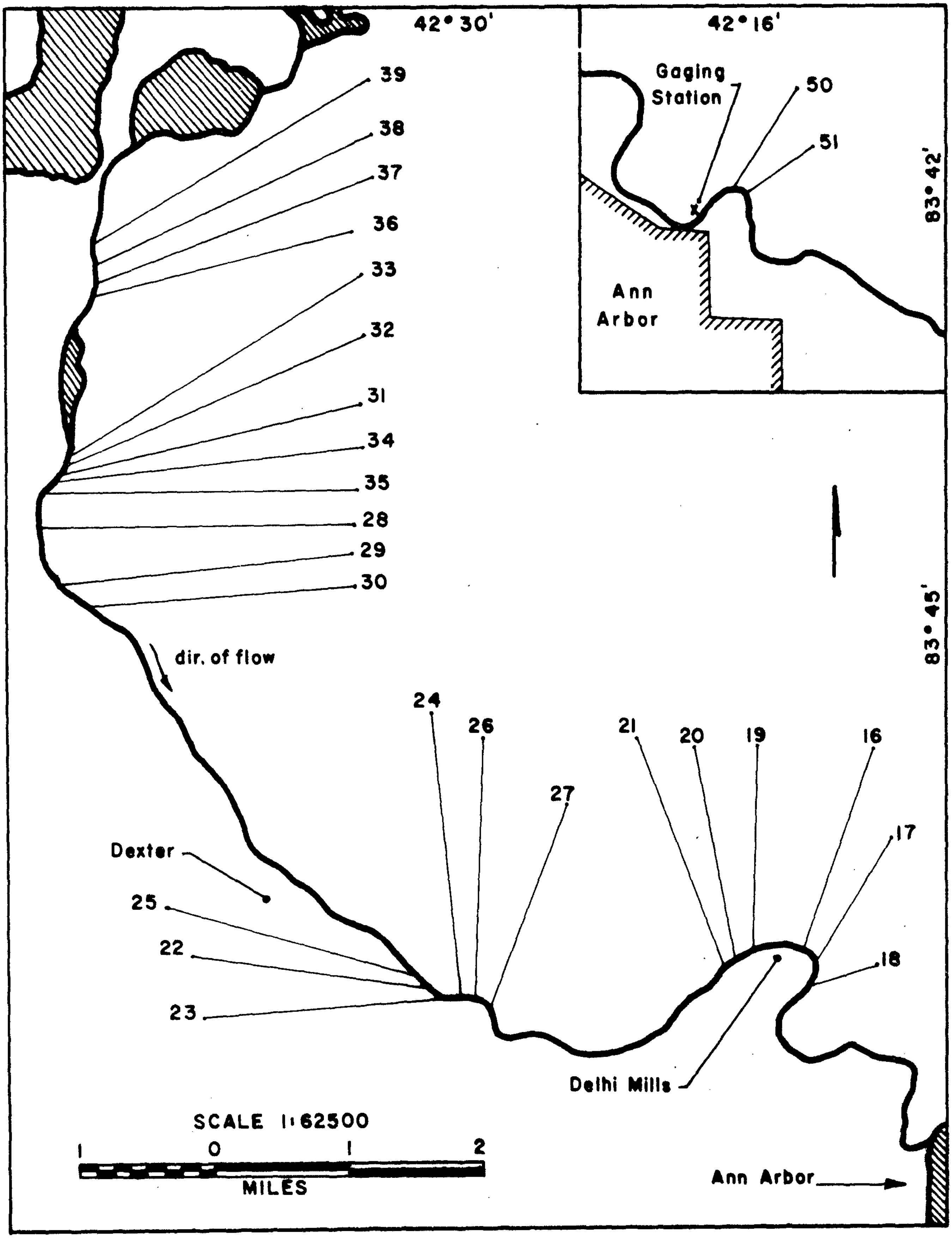
BLACK RIVER

Figure 6



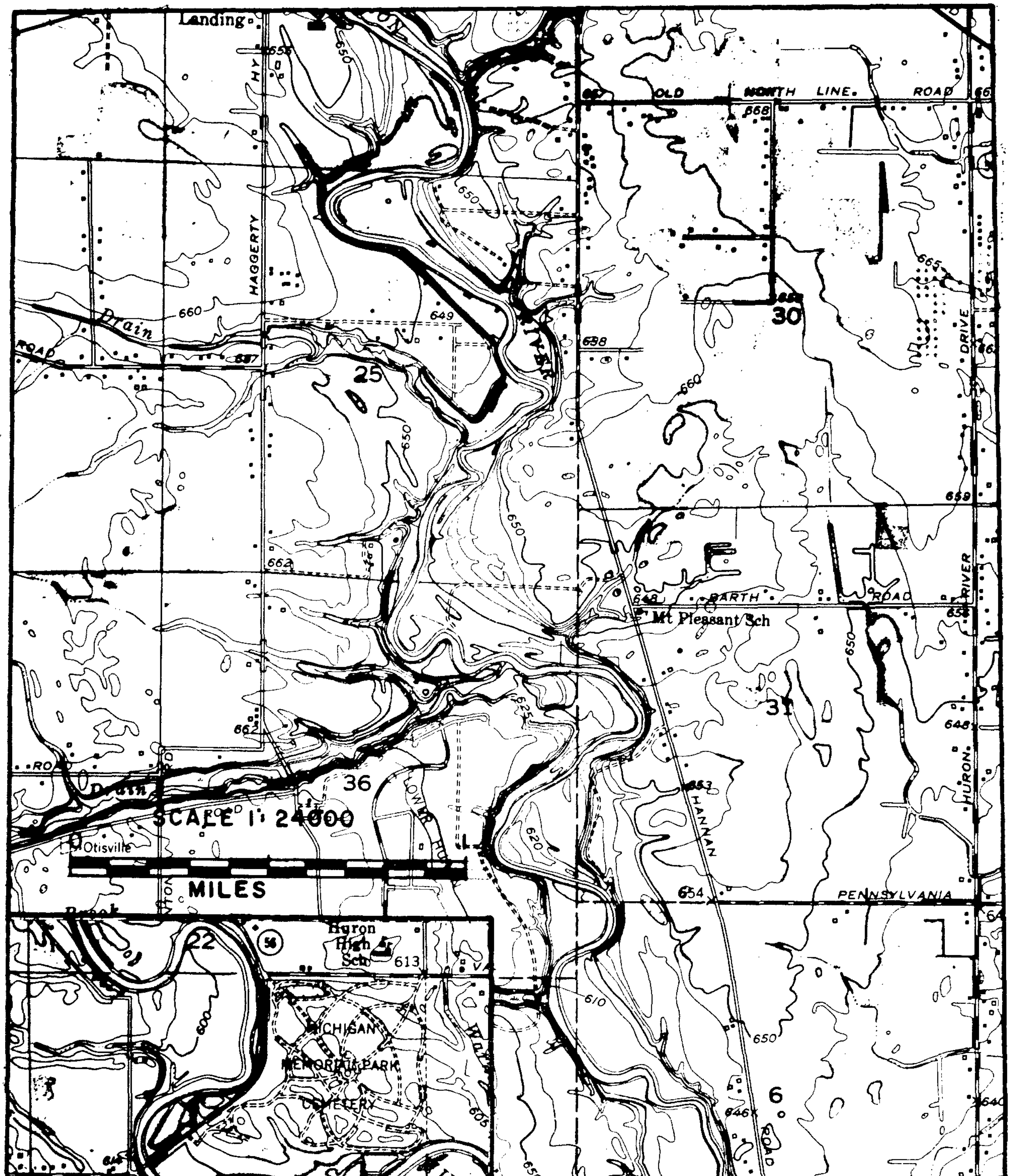
TOPOGRAPHY - UPPER HURON RIVER AREA

Figure 7



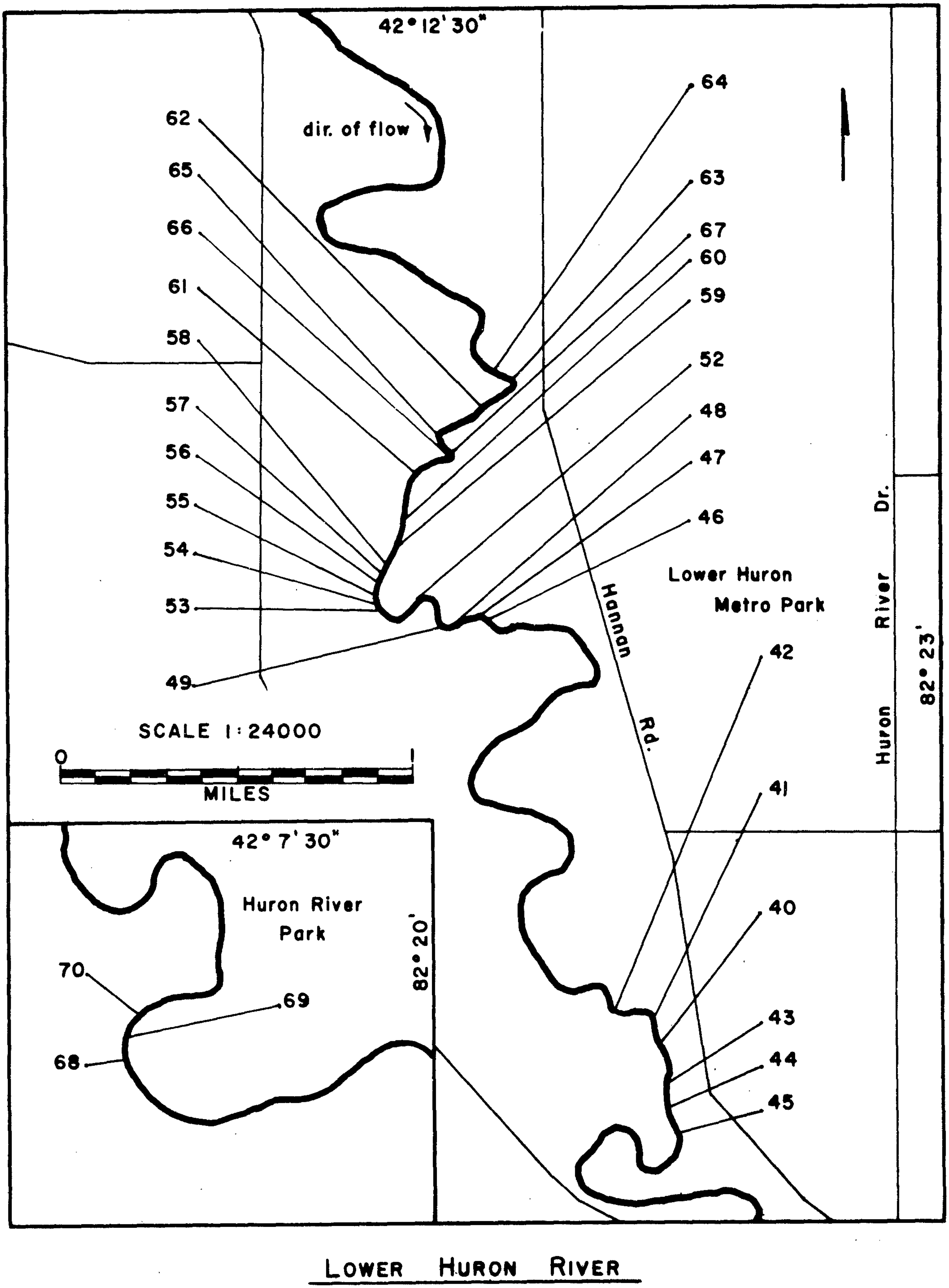
UPPER HURON RIVER

Figure 8



TOPOGRAPHY - LOWER HURON RIVER AREA

Figure 9



LOWER HURON RIVER

Figure 10

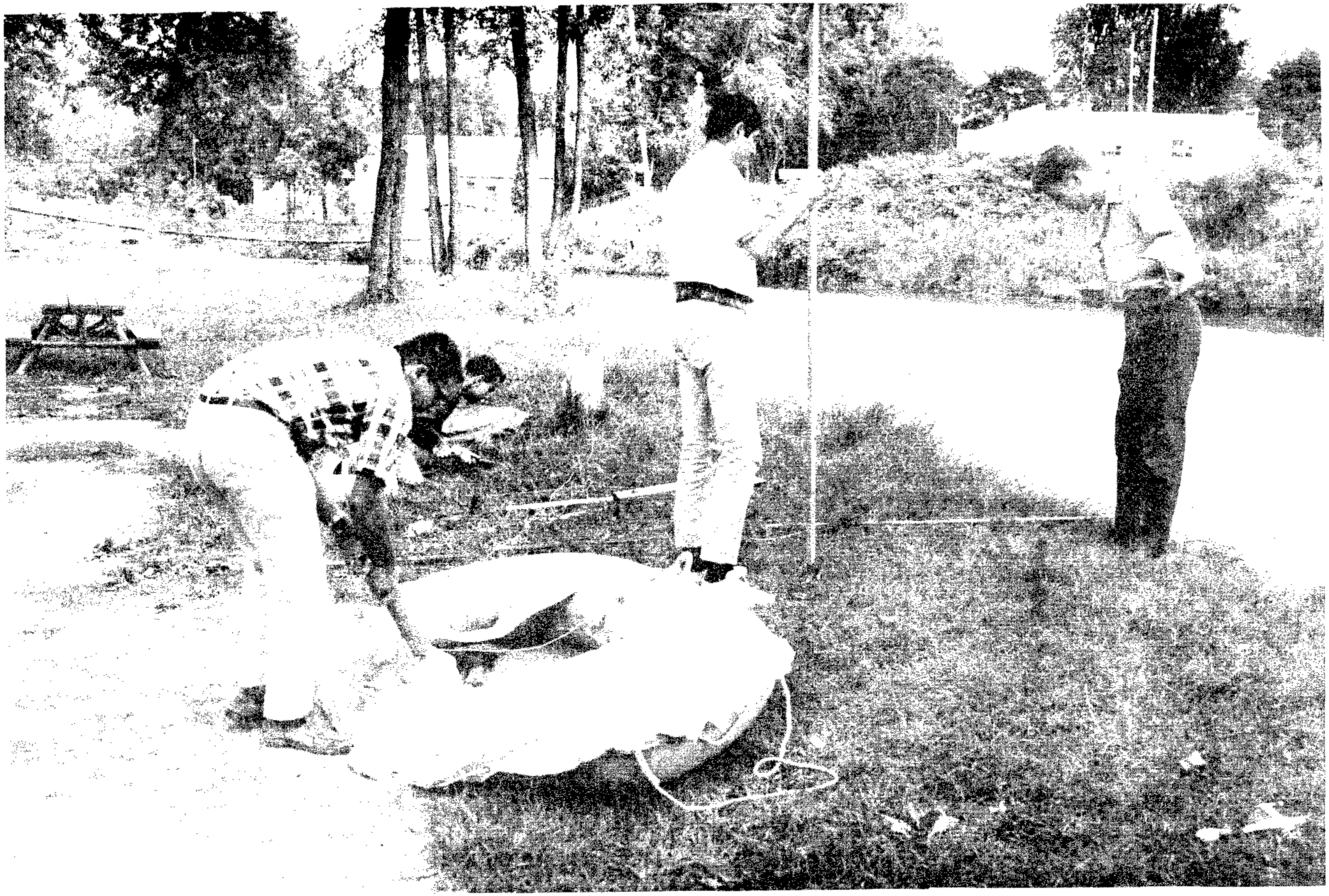
A test crew of six persons with a graduate civil engineer as the field supervisor was assigned the task of taking the measurements. They were instructed to take measurements of:

1. Cross section profile of the river.
2. Soil properties along the banks.
3. Channel bottom conditions and vegetation characteristics along the banks.

Measurements of the cross sections were recorded with hand levels, tapes, and surveyor's staffs (Figures 11 and 12). The hand levels provided sufficient accuracy for the profile measurement and were much faster to use than the conventional tripod-mounted surveyor's transit. Profile elevations were recorded at significant breaking points along the river bottom and bank. In places where the river was too deep to wade, the bottom profile was measured by taking soundings from an inflatable rubber boat (Figure 13). In about three-quarters of the test sites the test crew was able to cross the channel using chest waders.

Measurements of soil properties were taken from the most representative soils along the profile. Measurements of shear strength were recorded with a Cohron shear graph (Figures 14 and 15). The test crew collected soil samples in jars near the sheargraph test points for measurements of natural moisture content and visual classification - i.e., sand, clay, Atterburg limits where applicable. The test team recorded general data on bottom conditions observed as they waded along the channel cross section, and on vegetation lining the banks and immediate floodplain. Some representative sites were selected for a more detailed analysis of vegetation.

In addition to these field measurements, data were obtained from the U. S. Hydrologic Survey concerning gage height measurements for the purpose of analyzing changes in water level occurring with time. Figure 16 is a graph showing the duration of particular water levels for the Black River. Figure 17 is a similar graph for the Huron River. Appendix A shows gage height measurements for all active gaging stations on the Black and Huron Rivers during the 1965-1966 water year in which the survey was made. Figures 2 and 3 show the location of these gaging stations. Figure 18 shows the location of all gaging stations in the lower Peninsula of Michigan. Figures 19 through 24 are photographs of some representative test sites.



SETTING UP THE TEST EQUIPMENT

Figure 11

Measuring the Bank Profile

Figure 12

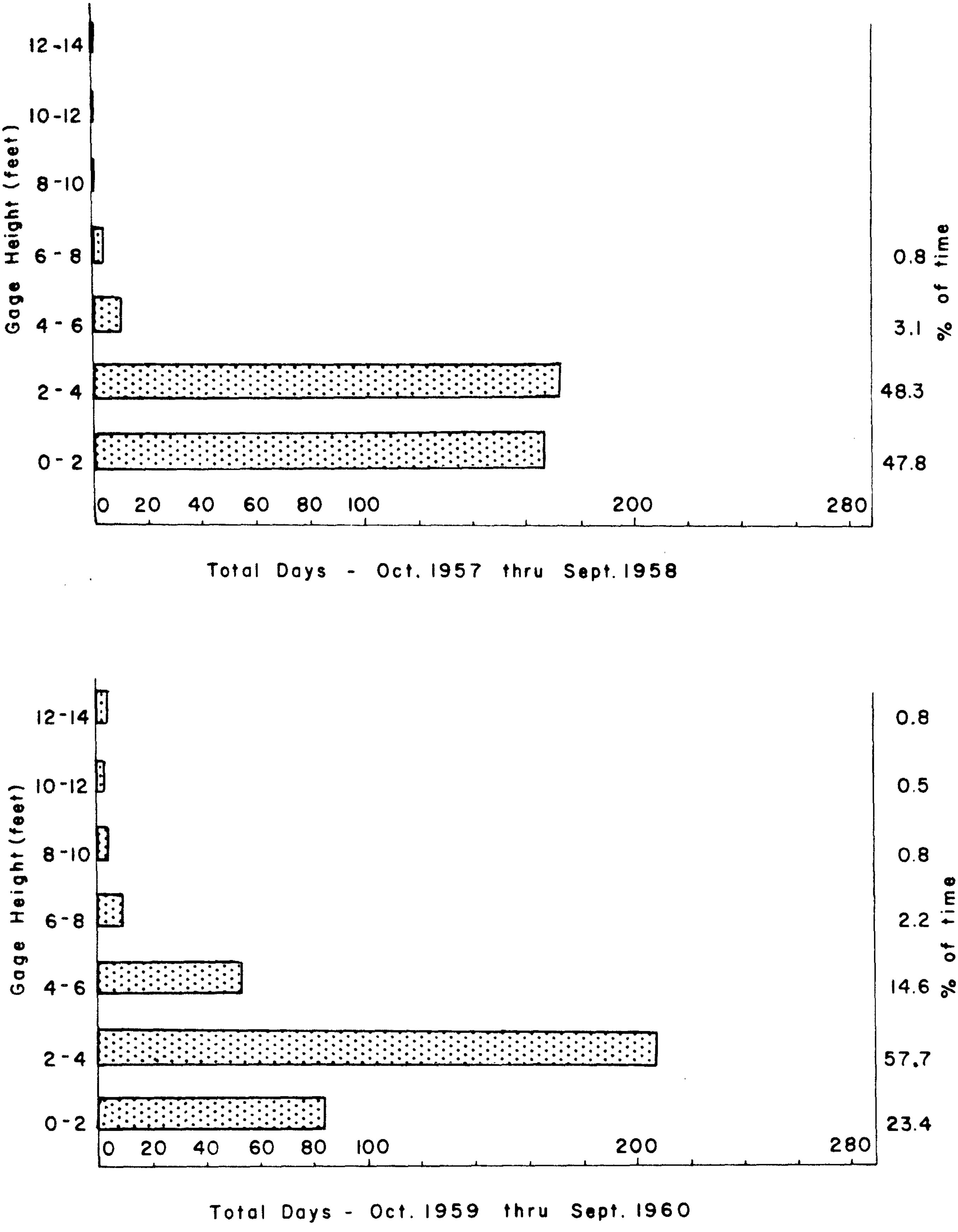
MEASURING THE CHANNEL PROFILE

Figure 13

OPERATIN[illegible]

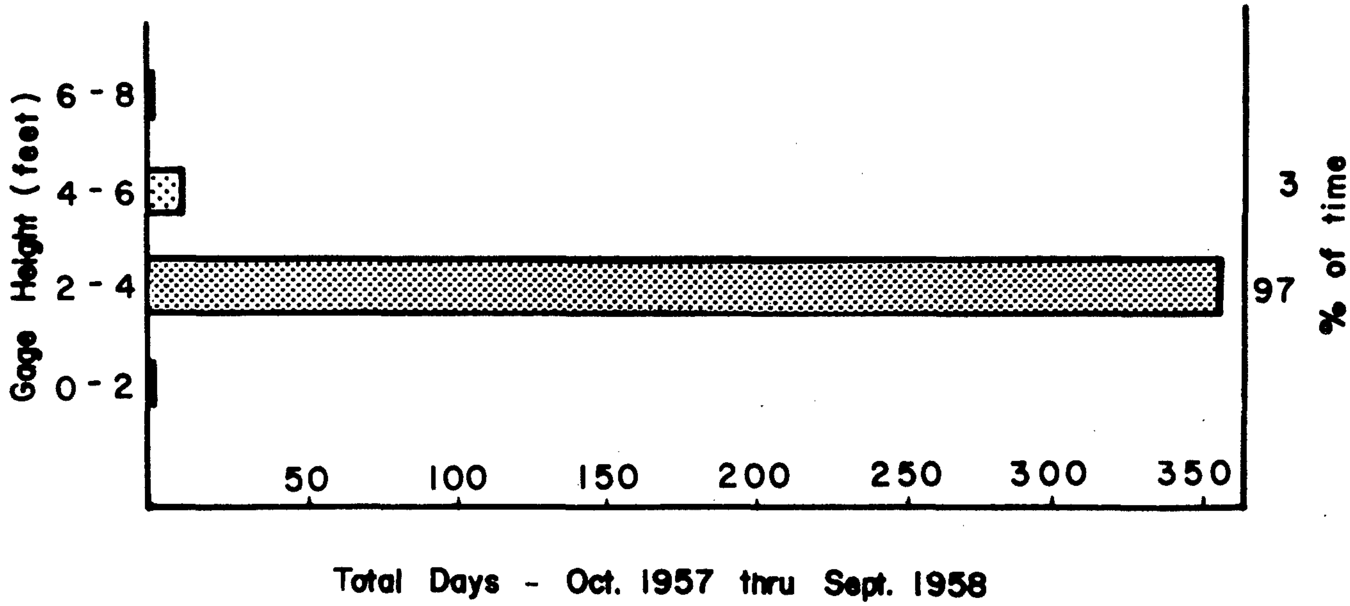
SHEARGRAPH MEASUREMENT ON THE BANK

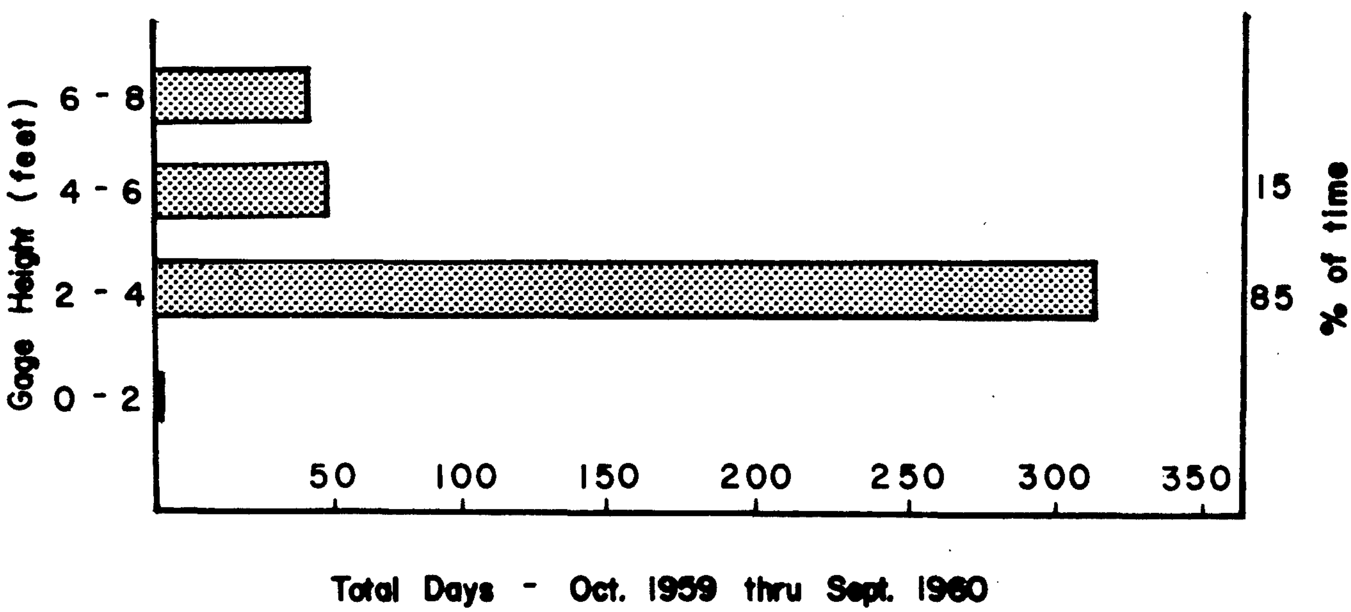
Figure 15



SEASONAL GAGE HEIGHT COMPARISON - BLACK RIVER

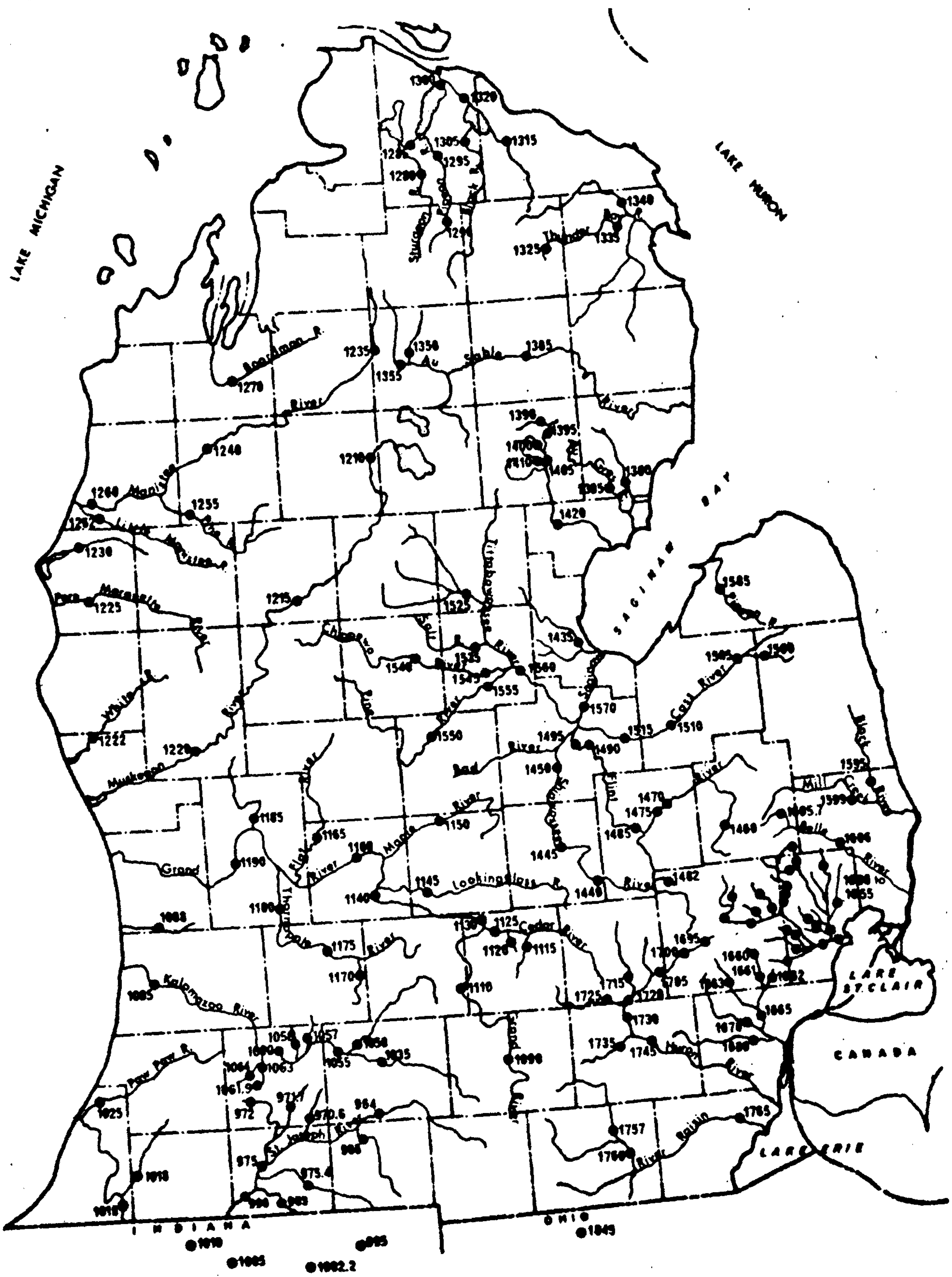
Figure 16





SEASONAL GAGE HEIGHT COMPARISON - HURON RIVER

Figure 17



ref: "Water Resources Data for Michigan - 1965", p.13

GAGING STATIONS - LOWER PENINSULA OF MICHIGAN

Figure 18

Black River - Vicinity of Site I

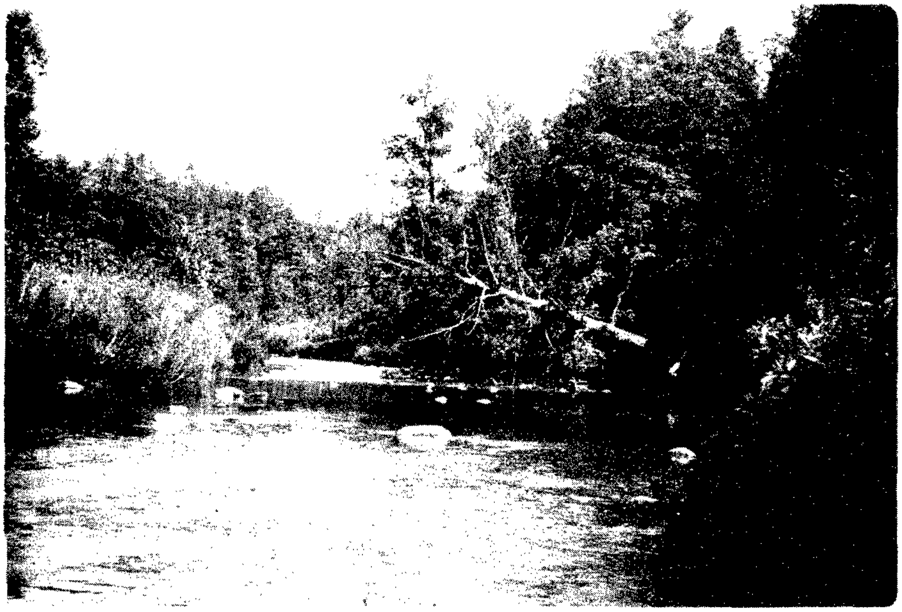
Black River - Vicinity of Site 2

Figure 19

Black River - Vicinity of Site 4

Black River - Vicinity of Site 5

Figure 20



Black River - Vicinity of Sites 4-6

Black River - Vicinity of Sites 7-9

Figure 21

Huron River - Vicinity of Site 17

Huron River - Vicinity of Site 18

Figure 22

Huron River - Vicinity of Site 58

Huron River - Vicinity of Site 59

Figure 23

Huron River - Vicinity of Sites 38-39

Huron River - Vicinity of Site 62

Figure 24

IV. RESULTS

A. Cross sections.

Eighty-two test sites were surveyed for this pilot test study. Appendix B shows the cross section profile for each test site, soil data, and estimated high water mark.

Preliminary analysis of the data indicates a general relationship between the character of the channel profile and its position on the meander. For the Black River, 1.6 miles, or about 8400 feet, were surveyed. Twenty-seven profiles were measured for an average of one profile per 310 feet. For the Huron River, 5.3 miles, or about 28,000 feet, were surveyed. Fifty-five profiles were measured, for an average of one profile per 510 feet. Figure 25 shows the approximate bank slope for each river in degrees versus the percent of occurrence. Figure 26 shows a preliminary analysis of the mobility of an M-113 armored personnel carrier on the test site along the Black and Huron Rivers. (See Ref. - Sloss 1967, for an explanation of this analysis.) This preliminary analysis utilizing a severity index indicates a fairly high number of exiting windows on both rivers.

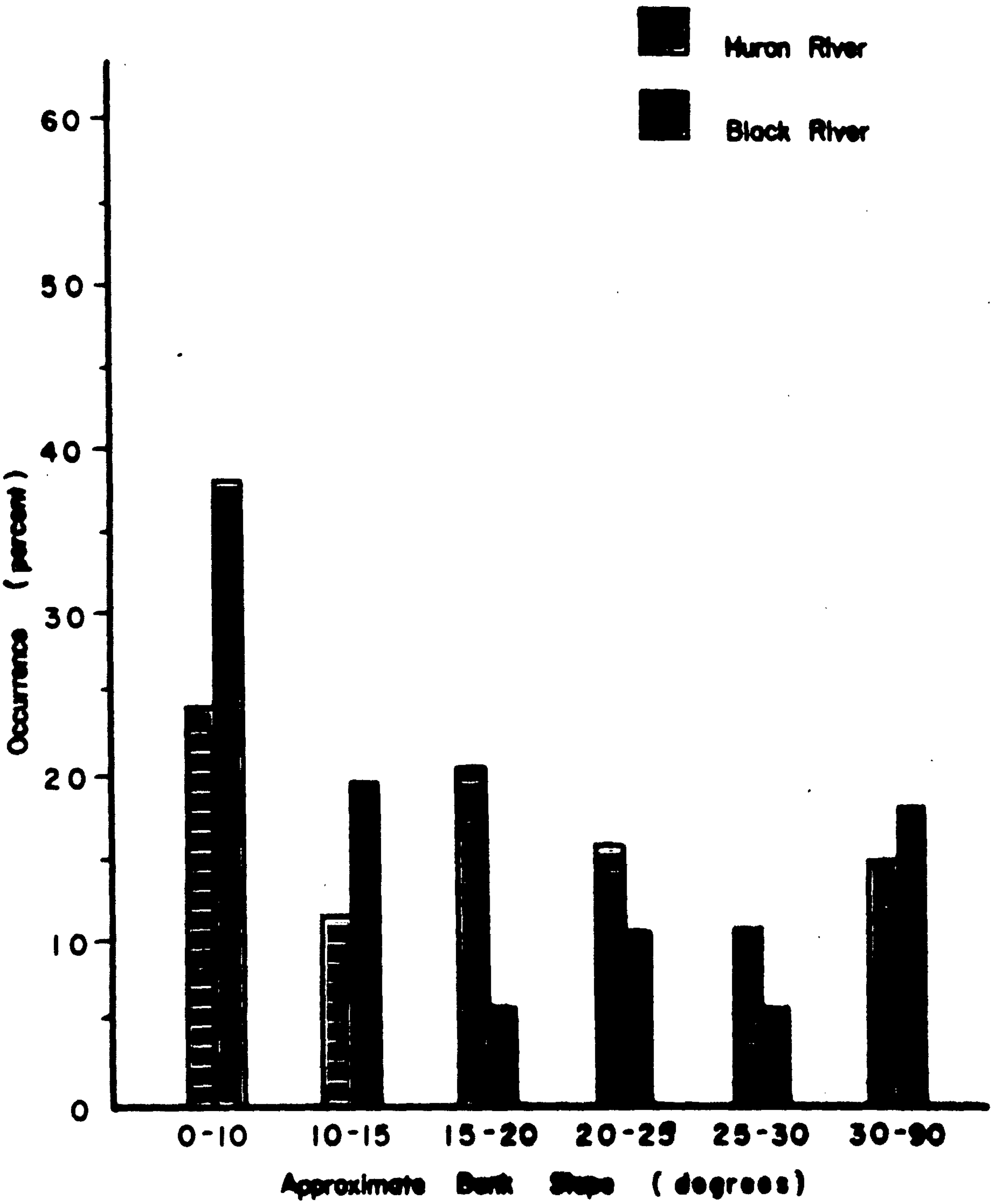
B. Soils.

1. Banks.

The soil properties measured were shear strength and cohesion. In general, high moisture content was associated with banks having the flatter slopes. The cohesion never exceeded 8 psi and was generally between 1.4 and 3.5 psi. The soils were generally nonplastic or of low plasticity, ranging from sand and silty sands to organic silt - clays. Figure 27 is an example of the sheargraph measurements. The sheargraph data is included with the site profiles in Appendix B.

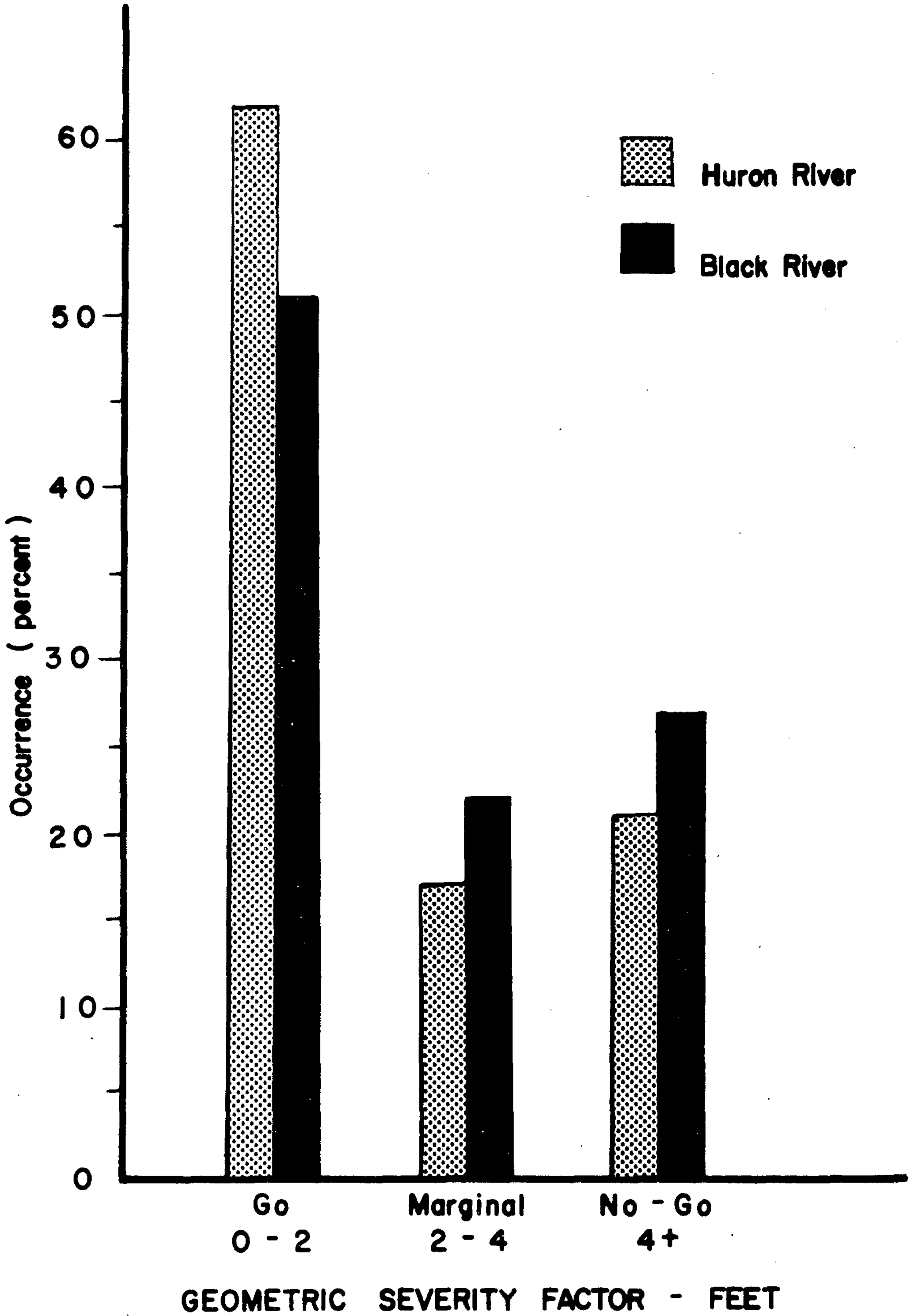
2. Bottom Conditions.

The test crew waded across about three-quarters of the test sites and observed that, in general, the bottom materials were gravelly on the inner or concave side of the meander, sandy in the middle section, and were predominantly composed of fine fractions, i.e., silts and clays, on the outer or convex side. This change was gradual with no appreciable boundaries.



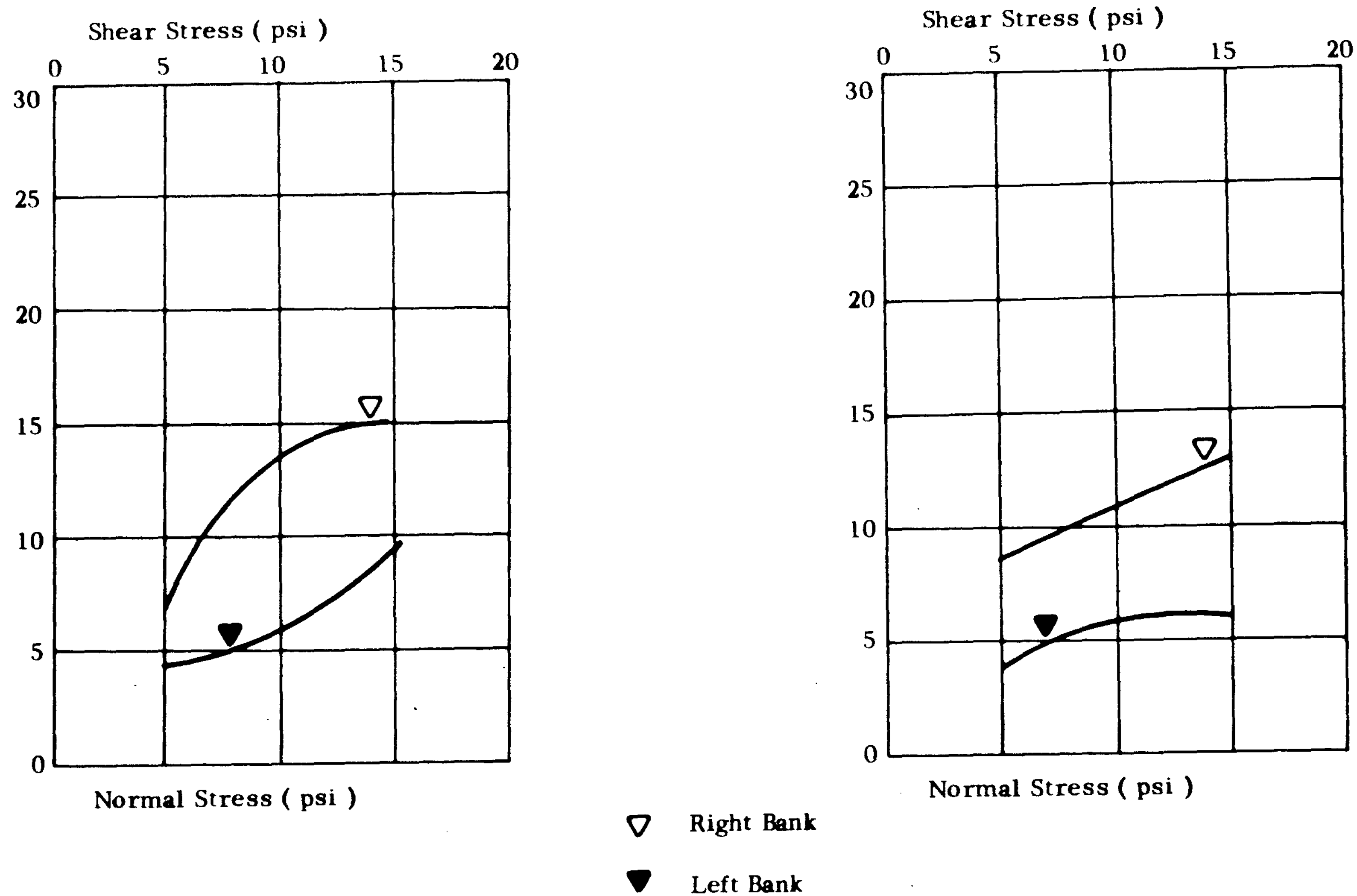
DISTRIBUTION OF BANK SLOPES ON THE BLACK AND HURON RIVERS

Figure 25



Estimated M-113 exiting performance for the Black and Huron Rivers using the geometric severity factor.

Figure 26



Sample Shear Data from Cohron Sheargraph Measurements

Figure 27

C. Vegetation.

Analysis of the detailed survey data from the representative sites shows that trees averaged about 8 to 10 inches in diameter and were spaced an average of 12 to 18 feet apart. The banks had abundant clumps of tall grasses and bushes such as willow and reeds. Size and spacing were similar for the two rivers.

D. Water Level.

Analysis of the gaging station has shown that:

1. Streams within the same general geographic area may have highly individual regimes. Water level varies seasonally about 4 to 7 feet with an extreme of 17.5 feet in the Black River and about 1 to 4 feet with an extreme of 8 feet in the Huron. These differences can be explained by local variations in physiography or by engineering modifications such as dams.

2. High water levels of 14 to 16 feet are of about two weeks duration. During the remainder of the year the water levels vary less than two feet.

V. DISCUSSION

A. Prediction Techniques.

The development of techniques for predicting the riverine environment can be an important development from this survey. Chang, Harrison, and Lassaline have conducted studies to determine soil characteristics in remote and inaccessible areas (Lassaline, 1965 and Harrison, 1966). Analogies have been developed for areas of the U.S.A., U.S.S.R., and Germany and field surveys have been conducted among predicted analogous soil areas in the United States. The results have been encouraging. If such an approach shows potential for soils, the same may be true for streams. The establishment of prediction techniques concerning mobility in the riverine environment would be highly important. It is impracticable

to survey all streams, and there are many streams in remote and inaccessible areas which would be impossible to survey by direct means. The present pilot survey has demonstrated that many significant riverine parameters can be measured and analyzed by conducting an intensive survey along a river. Therefore, through more surveys of this type between similar physiographic areas, it may be possible to establish prediction techniques similar to those previously developed for soil characteristics.

B. Identification and Classification of Important River Parameters.

Prediction techniques would be based on the identification and classification of significant river regime parameters, i.e., the total environment. Preliminary analysis of the Black and Huron survey data suggests some possible relationships between climate, geology, vegetation, soils, and perhaps cultural factors. Cohron, Holdridge, and Thornwaite have conducted some preliminary work in this subject area (Cohron, 1966). For example, Holdridge's "Life Zone" system correlates climatic conditions with vegetation. The character of a stream is in part determined by the volume, distribution, and run-off of the precipitation. Vegetation may absorb a significant portion of the precipitation. The Holdridge system relates evapotranspiration to rainfall, temperature, and vegetation. Thus, it may be possible to relate vegetation, among other factors, to the river regime. If these factors in the river regime were identified, classified, and possibly correlated, it may be feasible to establish river regime analogs for particular areas.

It may be possible to base a classification system upon such simple distinctions in geographic cycle such as youthful, mature, etc., or a more thorough analysis may be required, involving measurements of similar rivers in similar physiographic areas.

VI. CONCLUSIONS

The pilot study has demonstrated that intensive surveys along rivers are a feasible technique for collecting significant data on riverine parameters.

A preliminary mobility analysis shows that a substantial number of the test sites are negotiable. Other studies of stream frequency have shown a smaller number of negotiable sites (Ref. 6 and 7). It appears from the present study that particular streams offer more exiting windows than do others. This may be a function of the stage of the geographic cycle, i.e., youthful, mature, etc.

Analysis of the gaging station data has shown that substantial changes in water level would occur for brief periods of the year and that soil and vegetation characteristics would present few mobility problems along the Black and Huron Rivers.

VII. RECOMMENDATIONS

A. More effort should be directed towards developing prediction techniques.

B. Further analysis should be made of the relationship between significant factors in the riverine environment to form a better foundation for prediction techniques.

C. Additional surveys of this type should be conducted in differing physiographic areas for a comparison of riverine regimes, and to determine the frequency of exit windows for various types of rivers.

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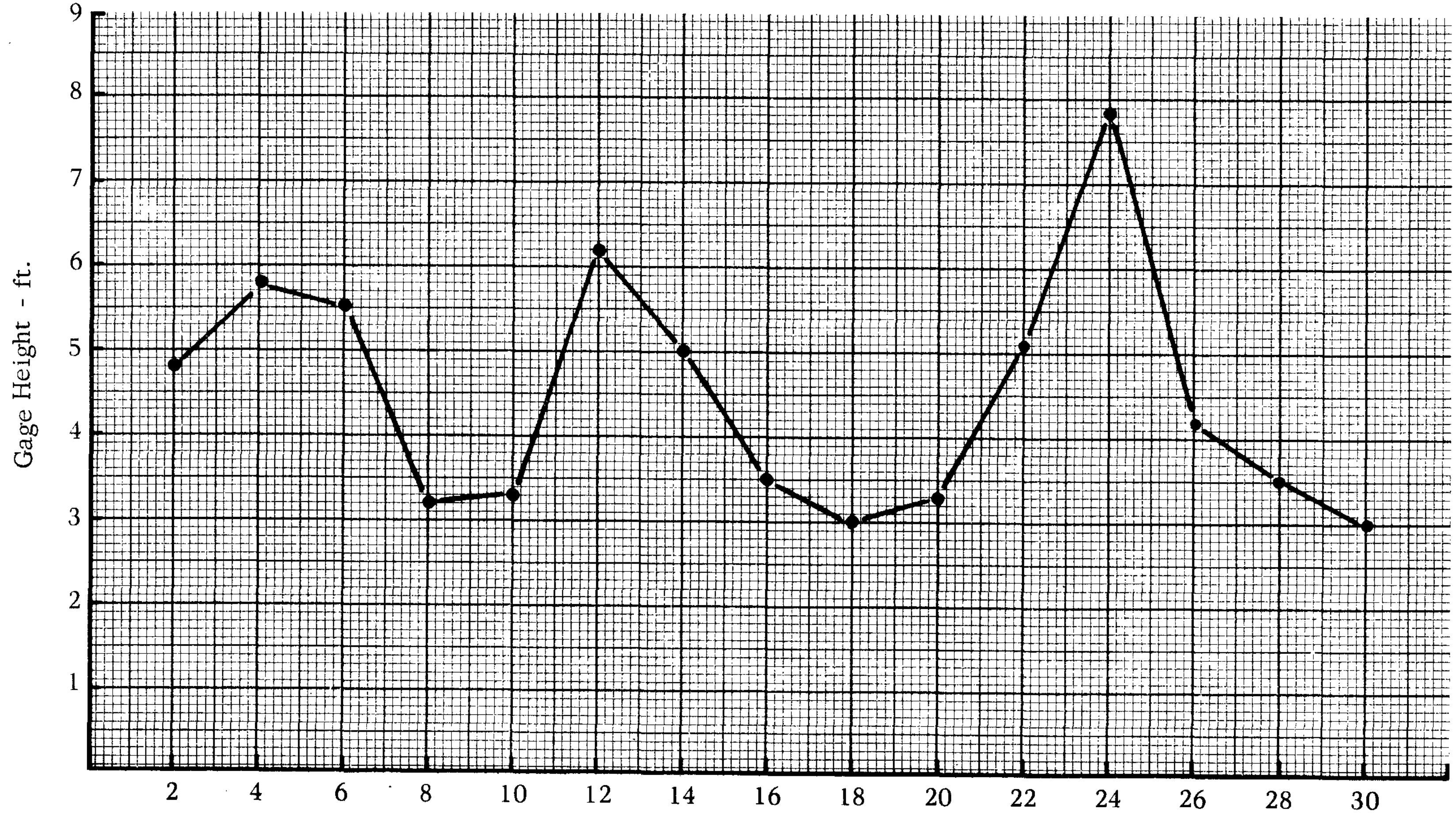
SUMMARY OF GAGING STATION DATA

River	Nearest Site	Station Number	Map[1] No.	Extremes: High - Low (feet)	1966 Water Year High - Low (feet)	High Water Month
Black	1	4-1595	1	18.05 -	8.43 - 1.62	March
Mill Creek[2]	71	4-1599	2	7.56 - .56	4.88 - .64	March
Huron		4-1695	1	3.10 - .52	1.68 - .74	May
Huron		4-1700	2	8.25 -	5.92 - 4.36	December
Huron		4-1705	3	5.05 - .53	1.86 - .58	December
Portage R.[3]	39	4-1725	4	5.72 - .56	3.10 - .60	May
Ore Creek[3]		4-1715	6	16.50 - 13.80	14.7 - 13.95	May
Mill Creek[3]	25	4-1735	7	12.2 - 4.94	9.92 - 5.16	December
Huron	30	4-1730	8	8.17 - 2.21	4.15 - 2.21	April
Huron	50	4-1745	9		15.08 - 11.50	July

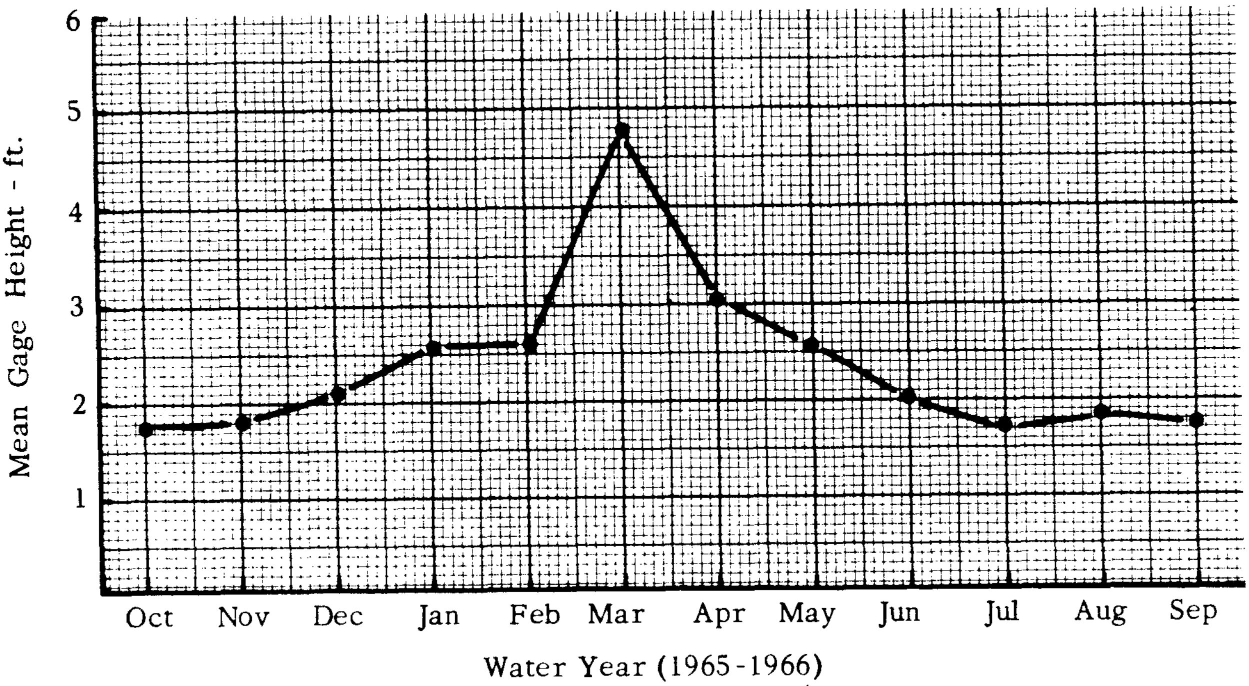
Note 1: For Black River see Figure 2. For Huron River see Figure 3.
Note 2: Tributary to Black River
Note 3: Tributary to Huron River



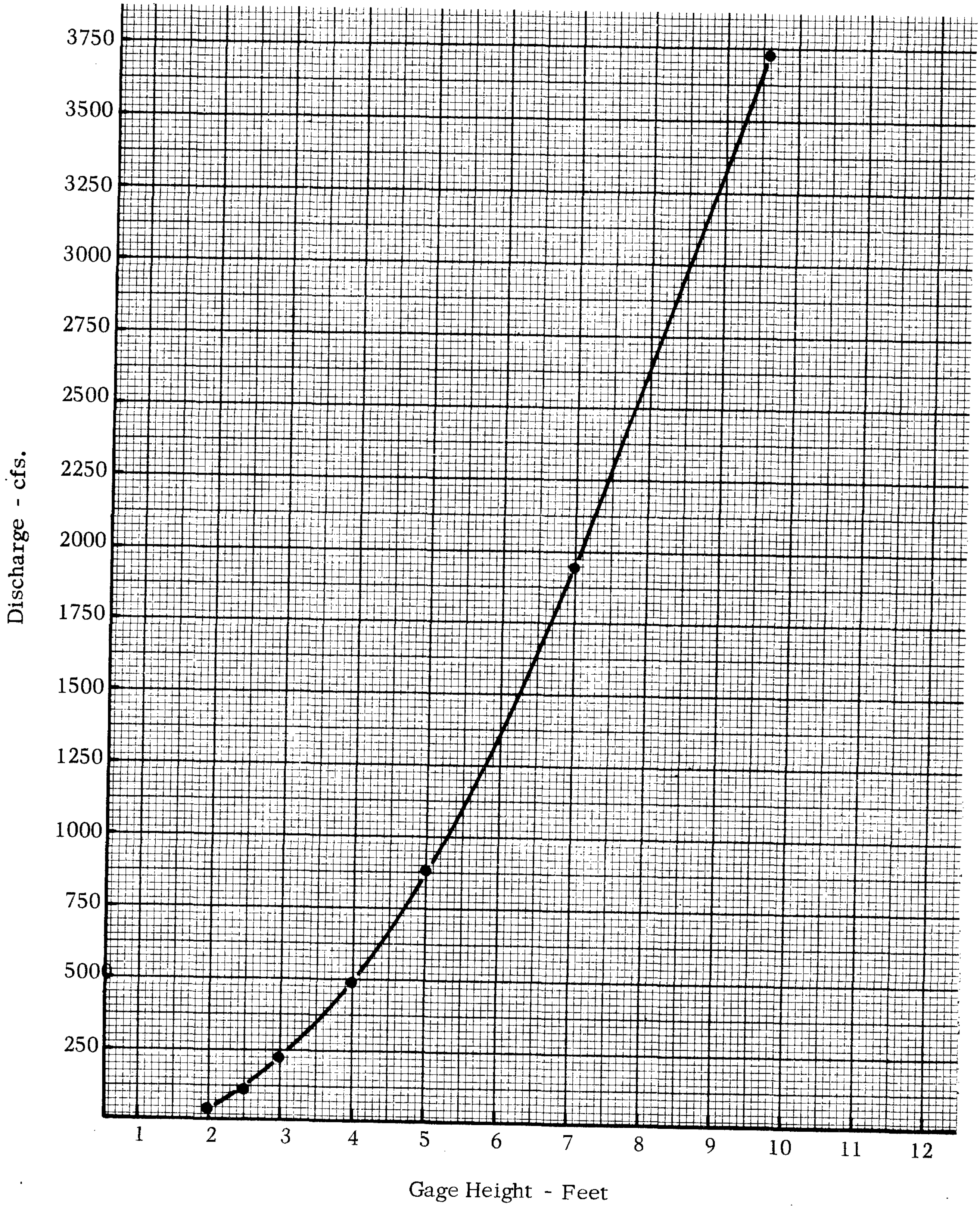
Maximum Gage Height (month of March, 1966)

BLACK RIVER NEAR FARGO 1*

*Note: See Map, page 3, for location of U.S.G.S. Gage Station



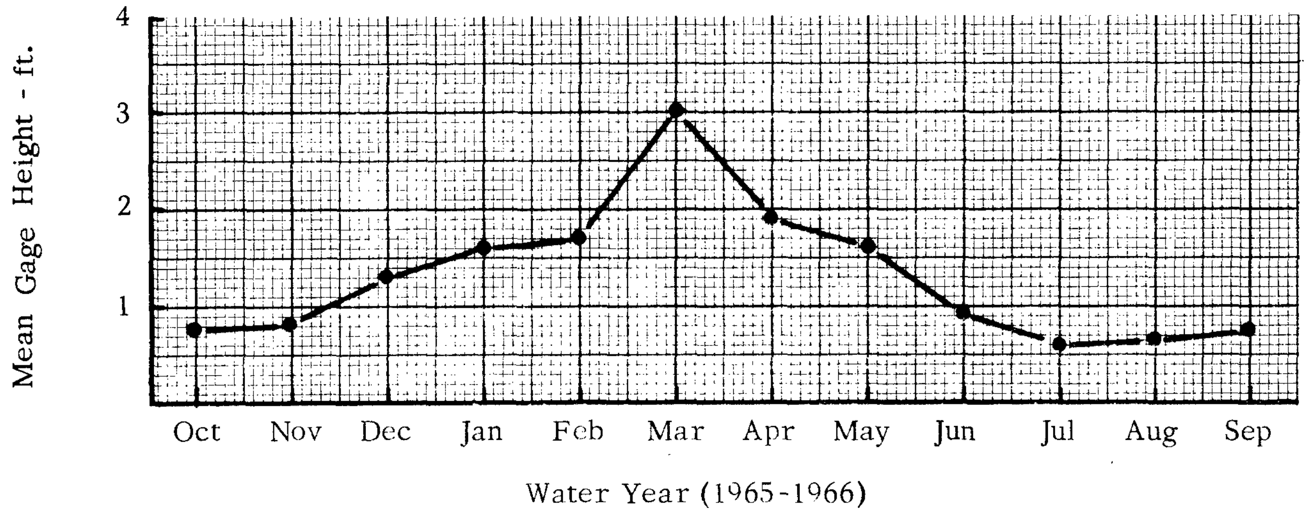
BLACK RIVER NEAR FARGO 1

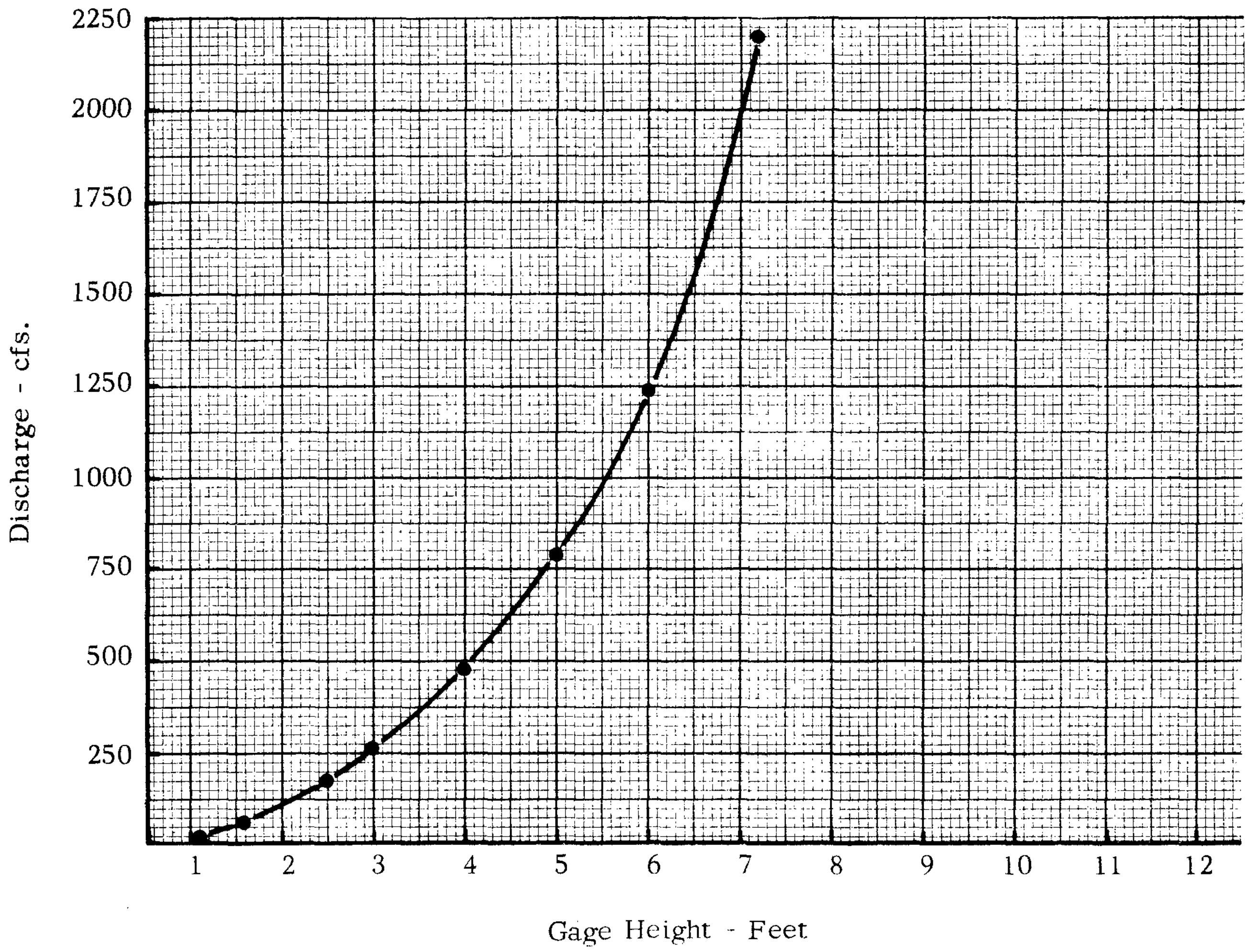


BLACK RIVER NEAR FARGO 1

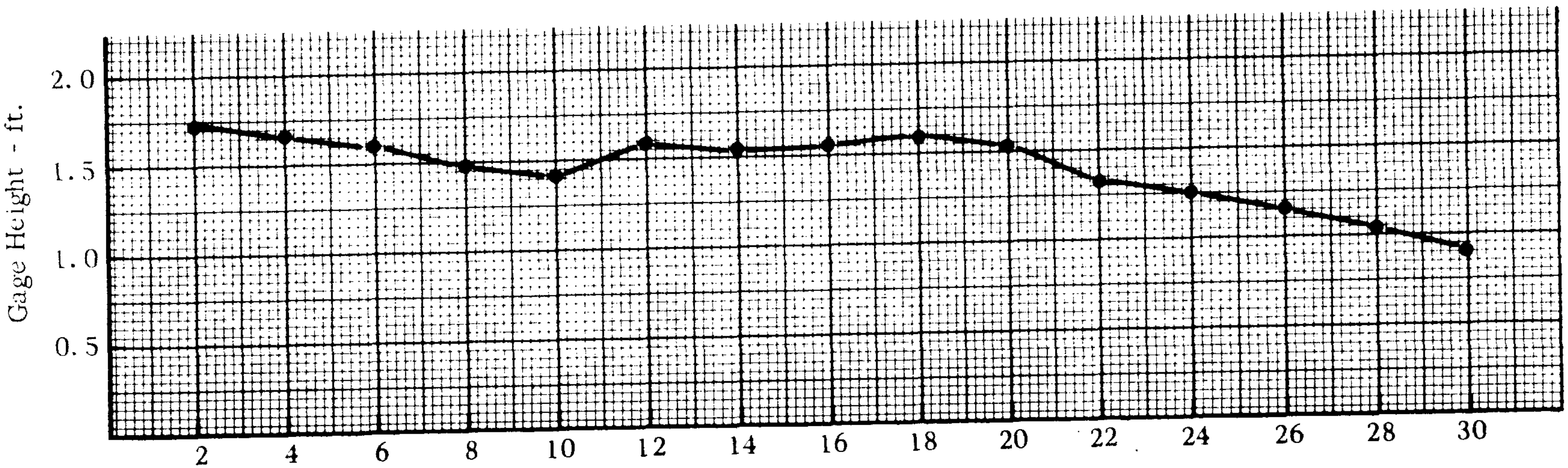
Maximum Gage Height (month of March, 1966)

MILL CREEK NEAR AVOCA 2





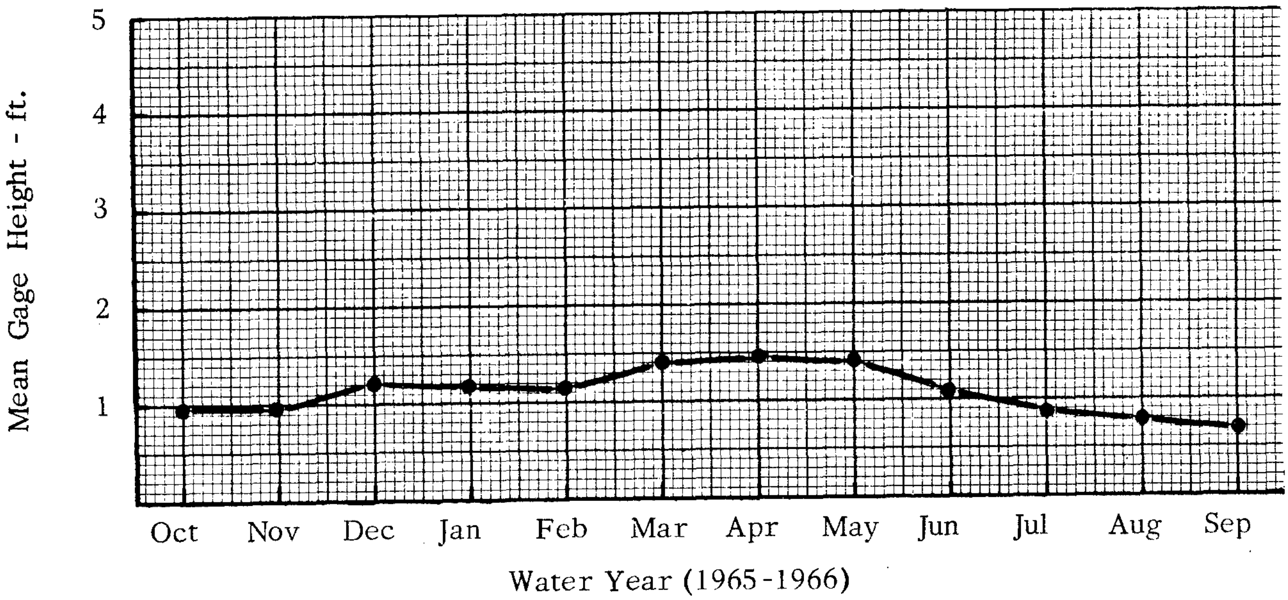
MILL CREEK NEAR AVOCA 2

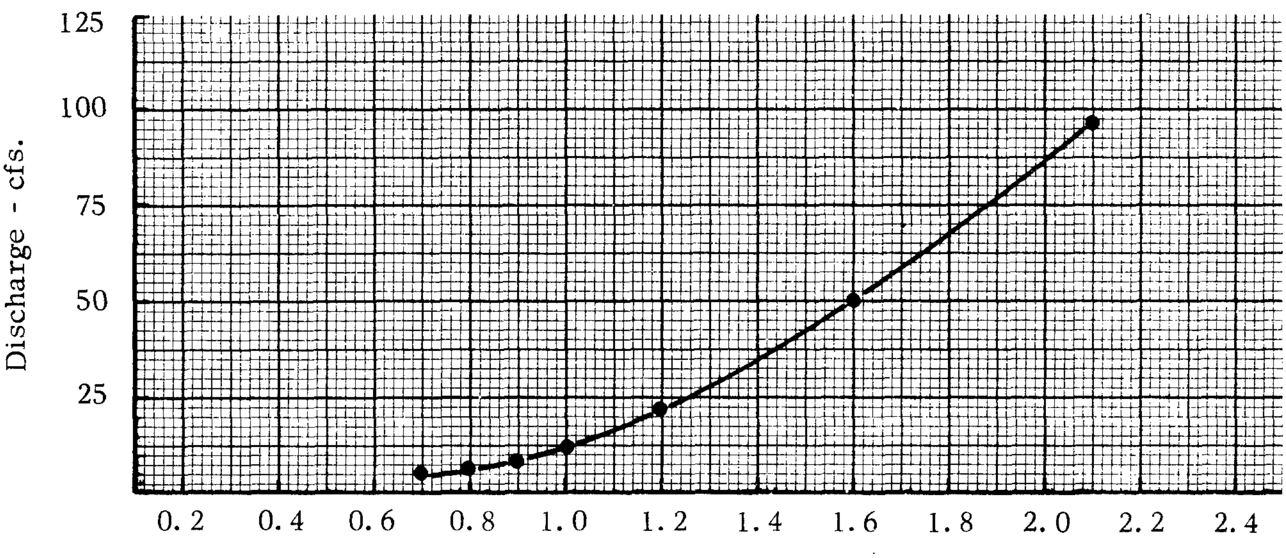


Maximum Gage Height (month of May, 1966)

HURON RIVER AT COMMERCE 1 *

*Note: See Map, page 5, for location of U.S.G.S. Gage Station

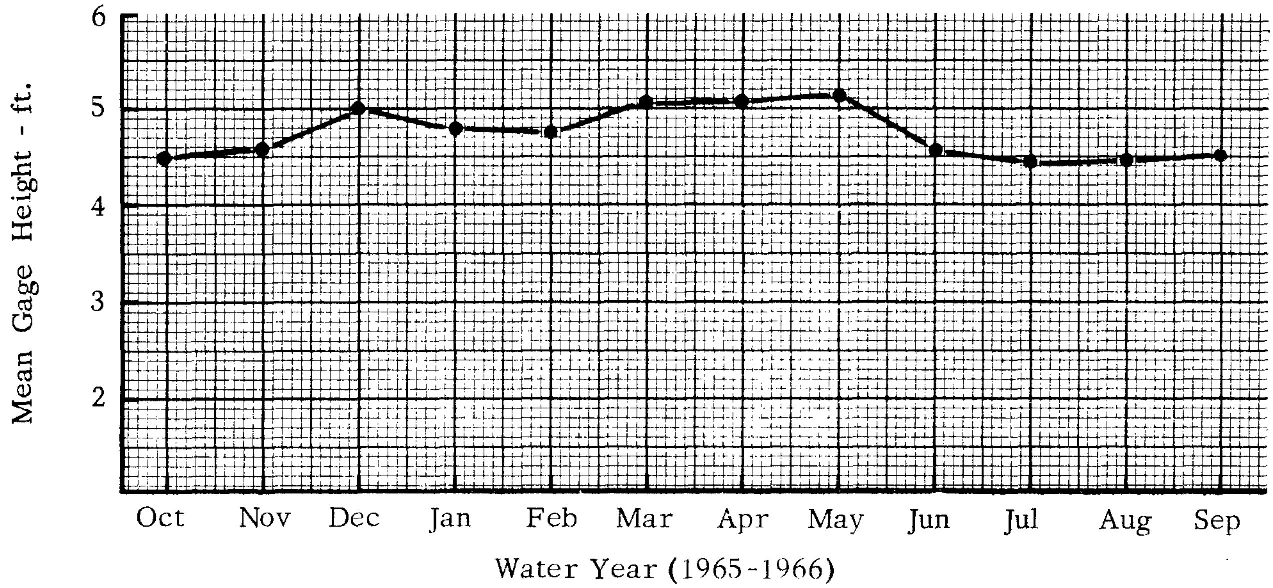


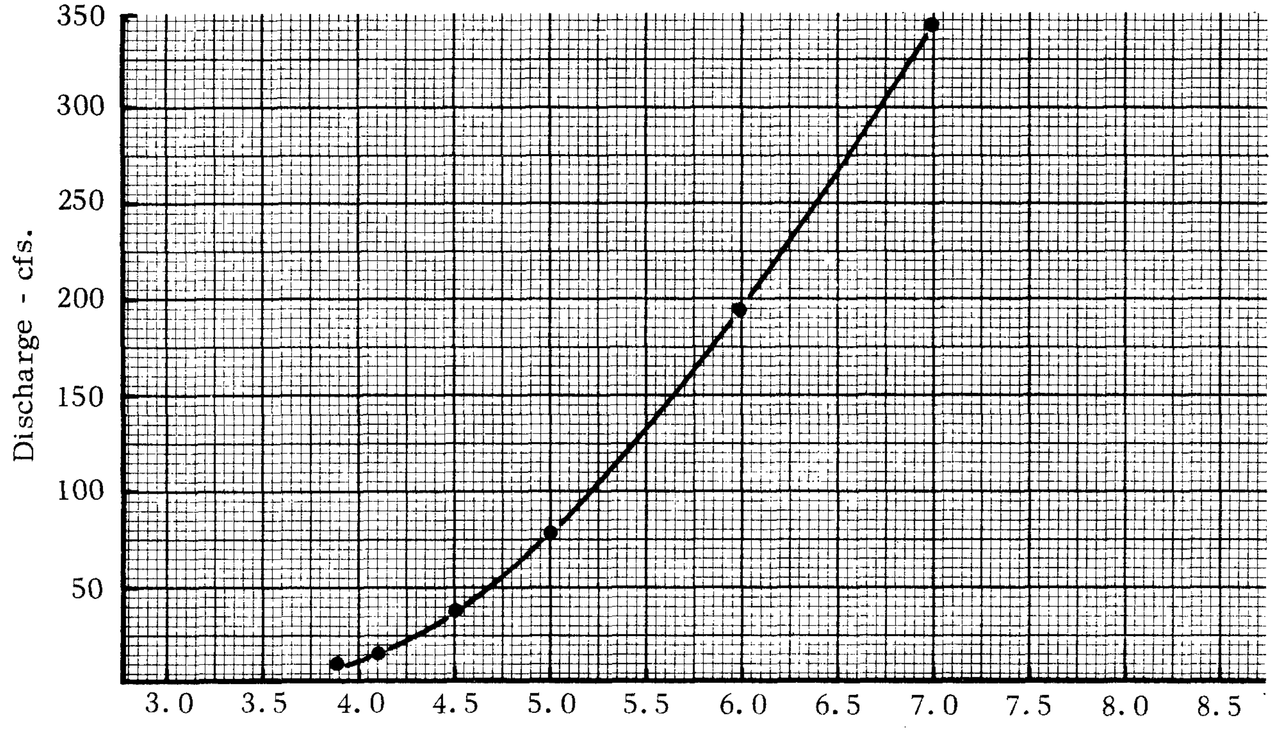


HURON RIVER AT COMMERCE 1

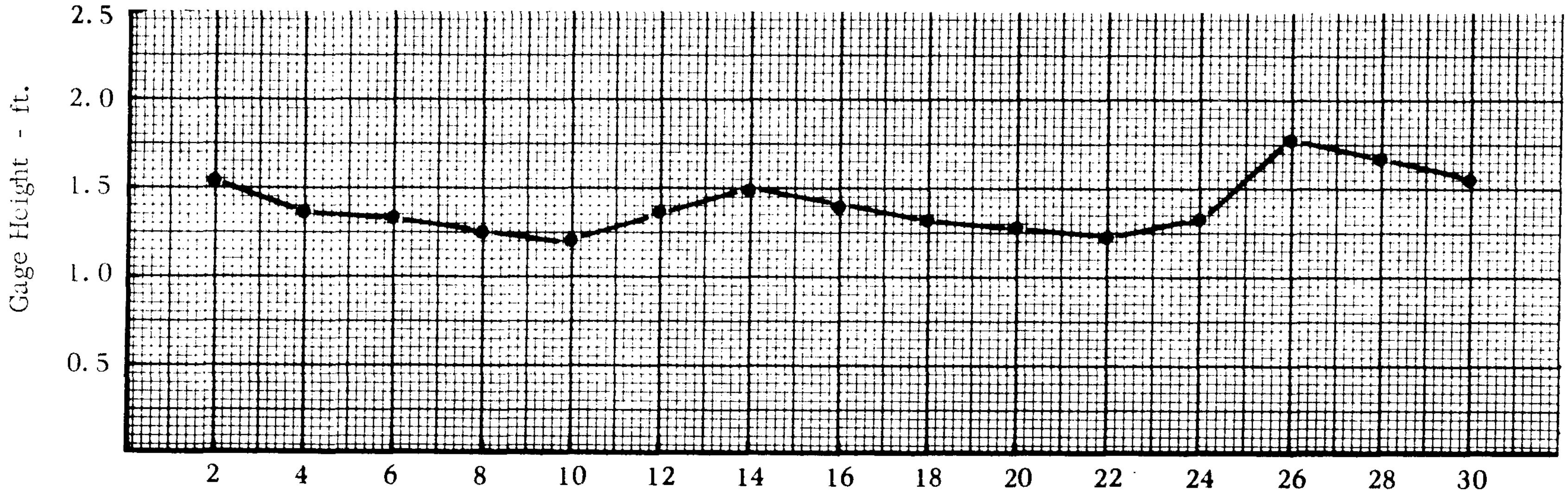
Maximum Gage Height (month of December, 1965)

HURON RIVER AT MILFORD 2



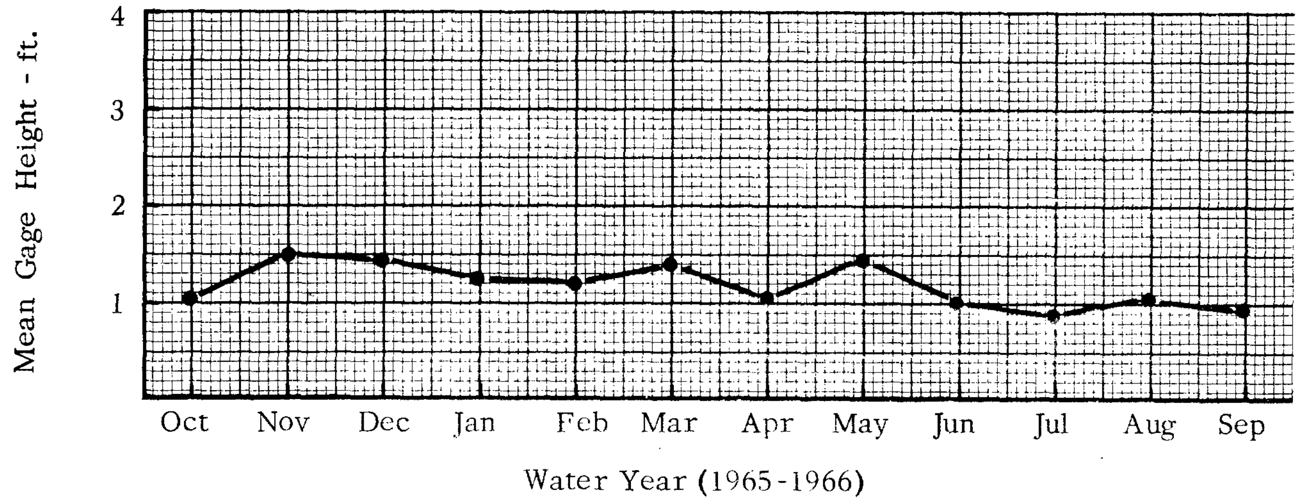


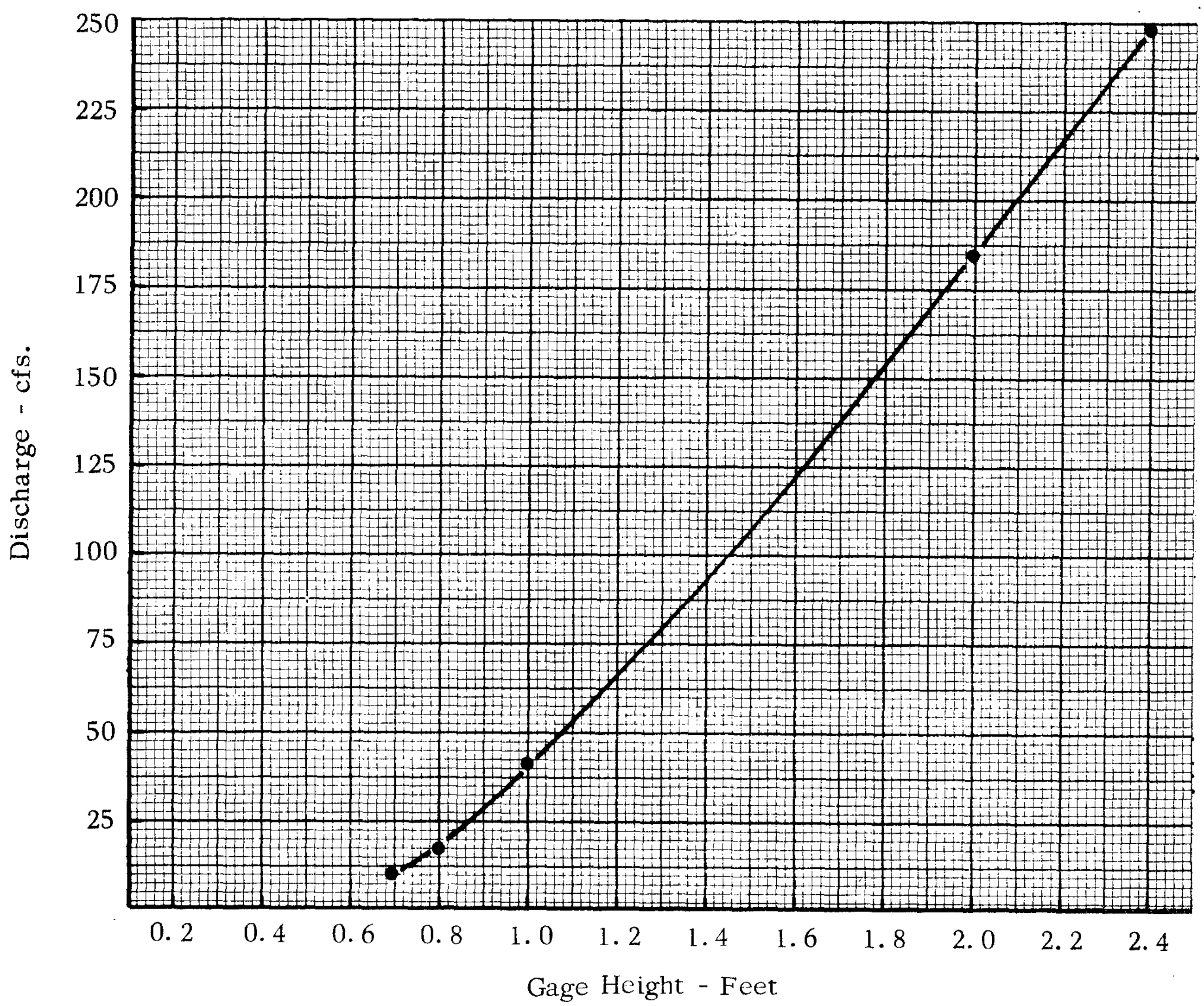
HURON RIVER AT MILFORD 2



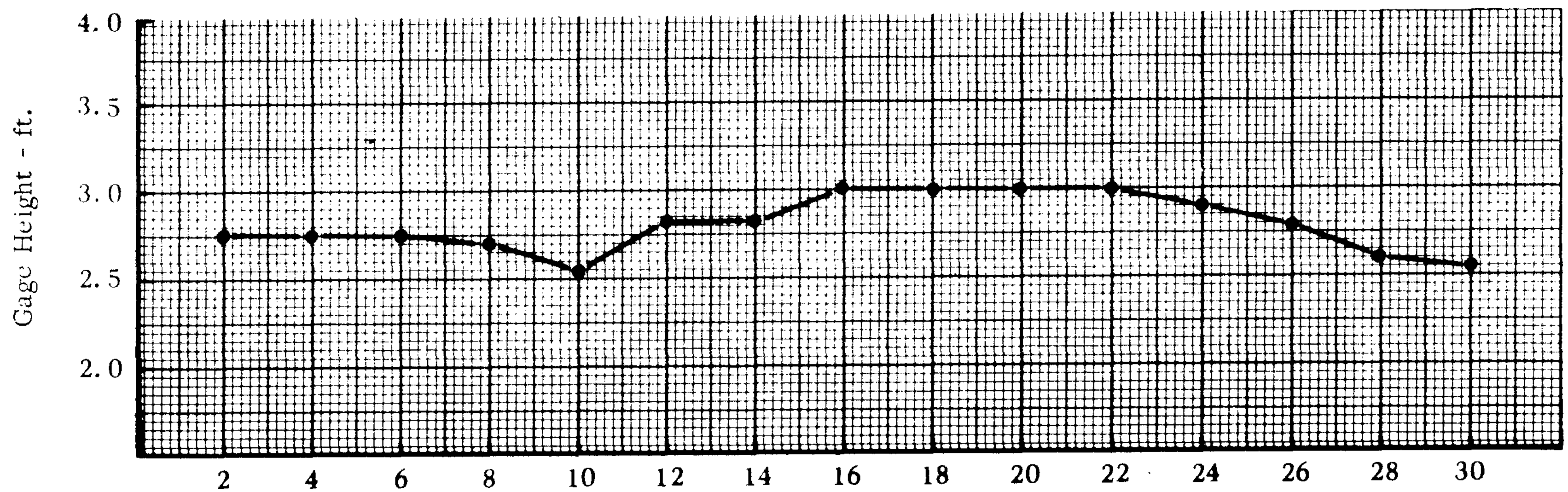
Maximum Gage Height (month of December, 1965)

HURON RIVER NEAR NEW HUDSON 3



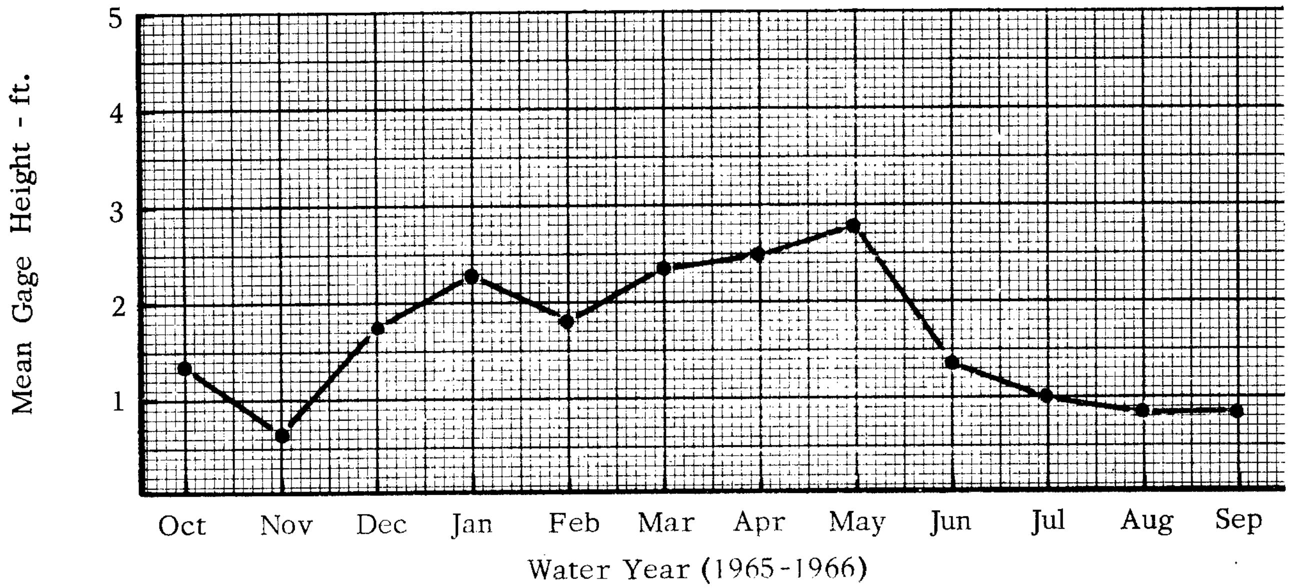


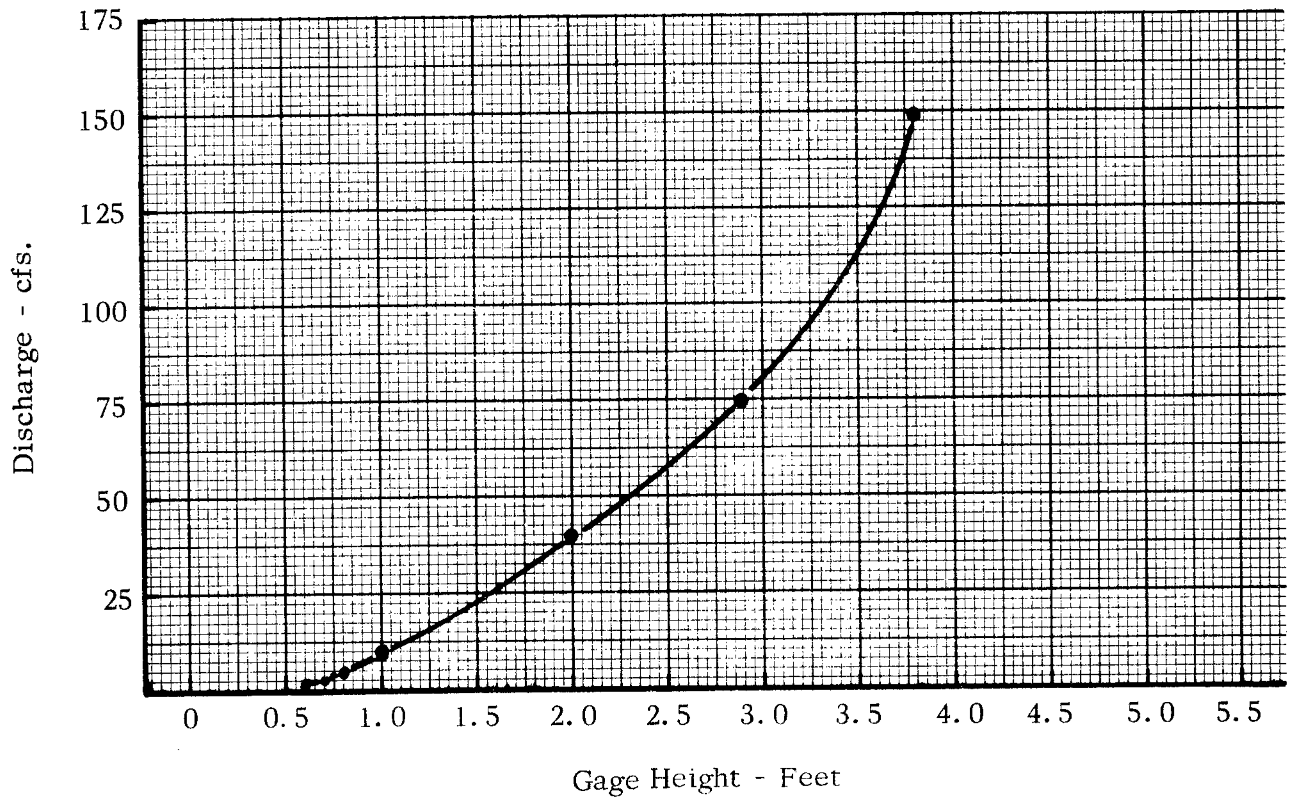
HURON RIVER NEAR NEW HUDSON 3



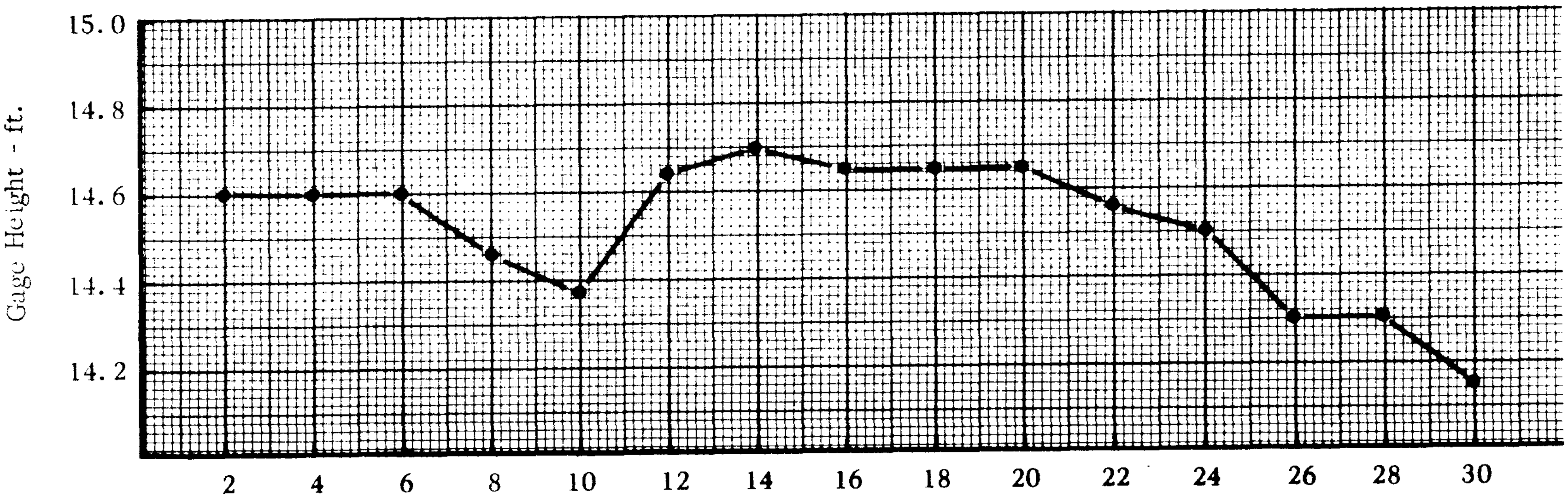
Maximum Gage Height (month of May, 1966)

PORTAGE RIVER NEAR PINCKNEY 4



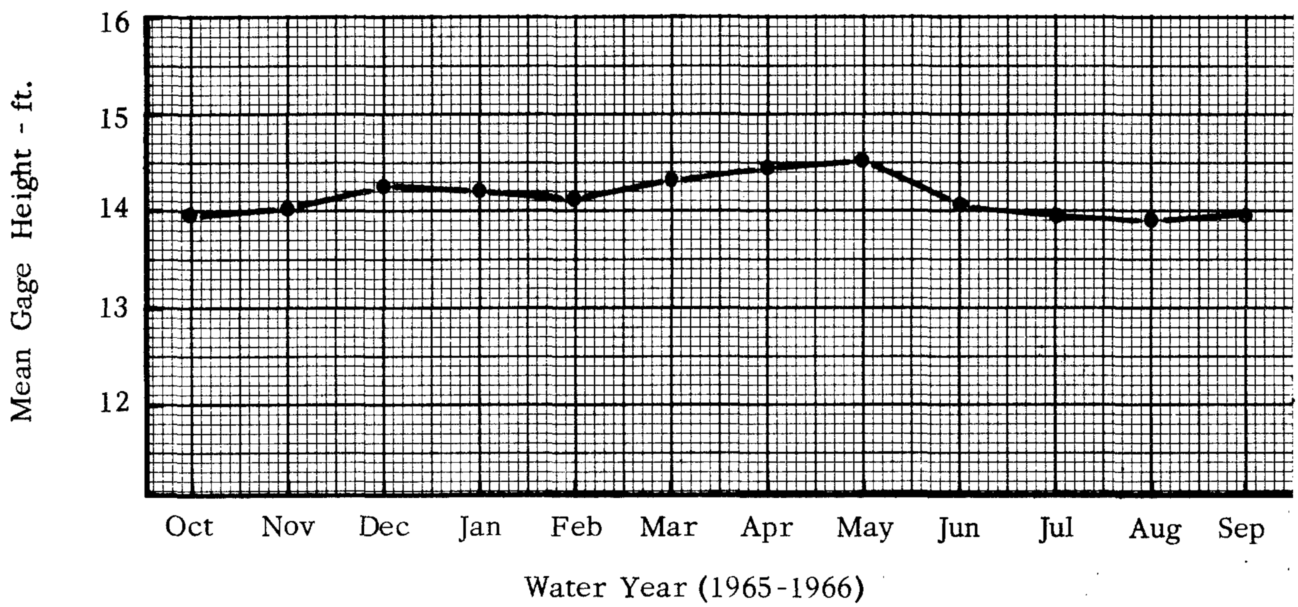


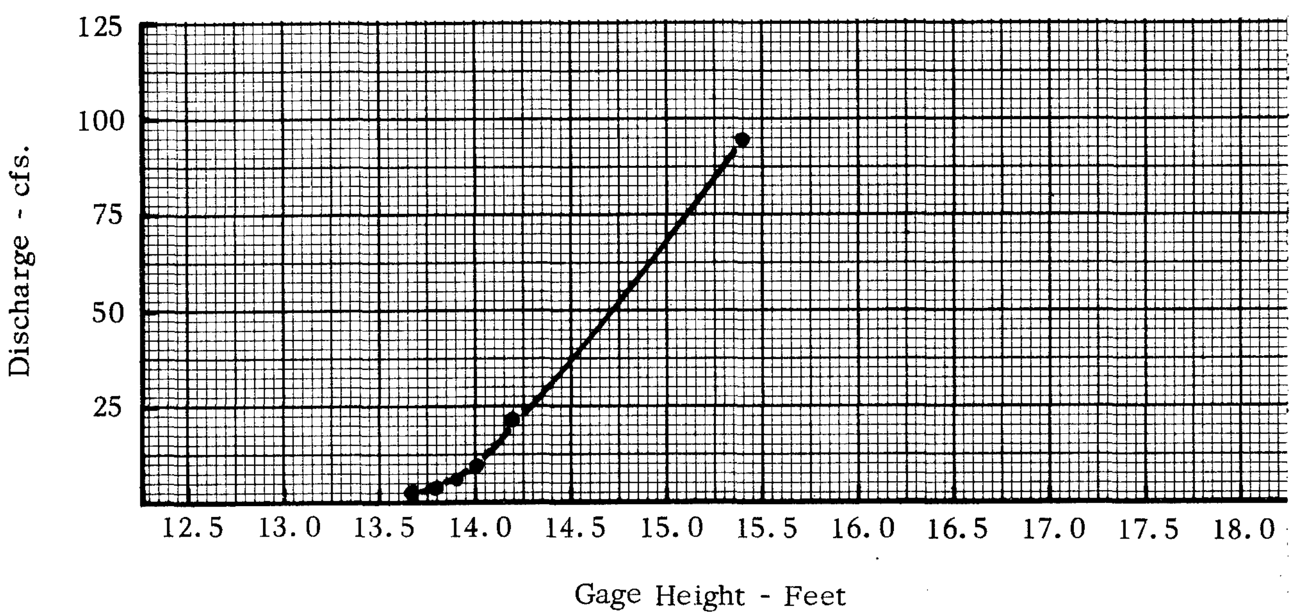
PORTAGE RIVER NEAR PINCKNEY 4



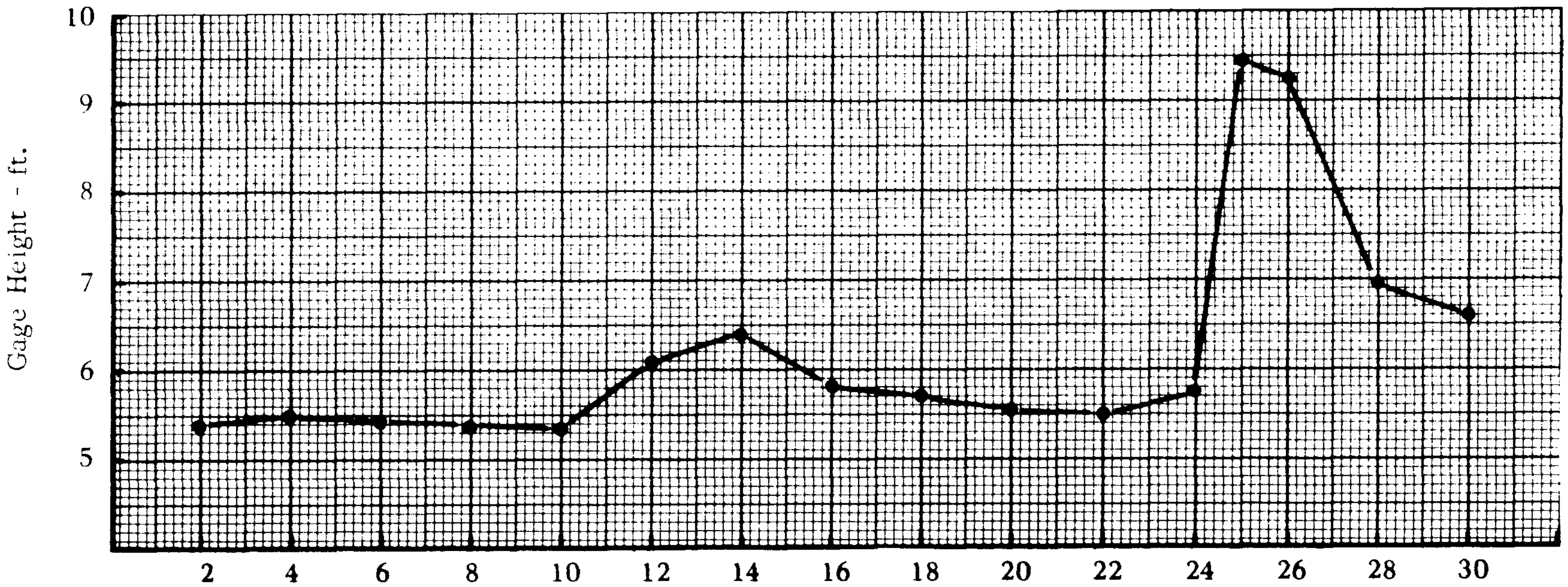
Maximum Gage Height (month of May, 1966)

ORE CREEK NEAR BRIGHTON 6



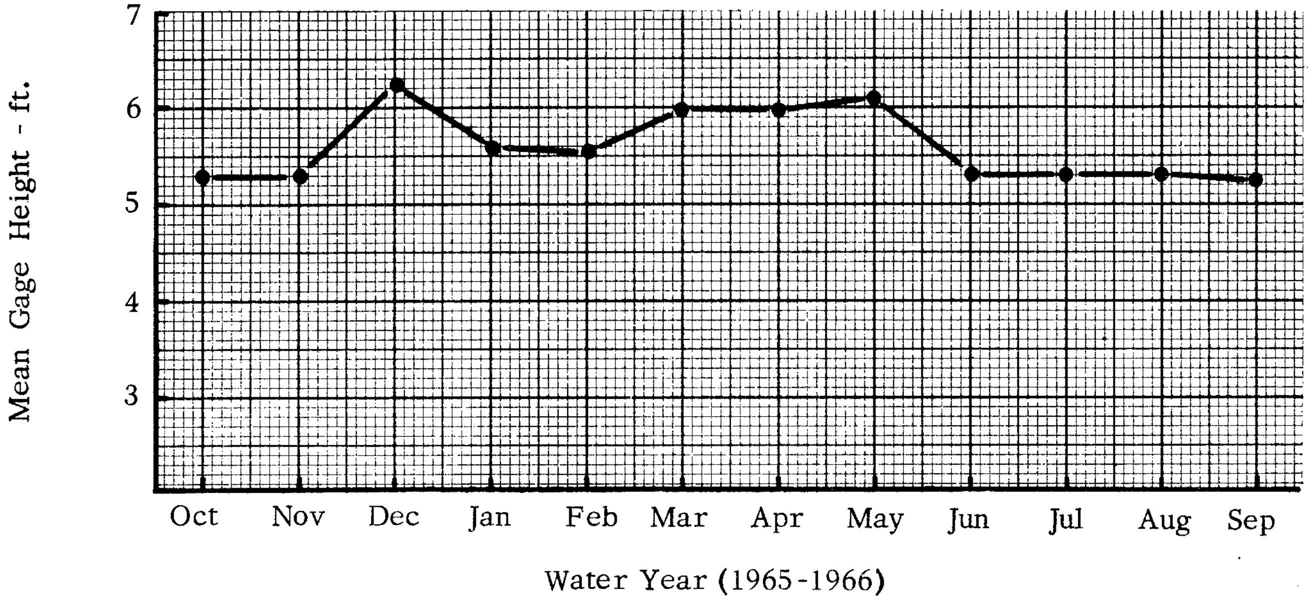


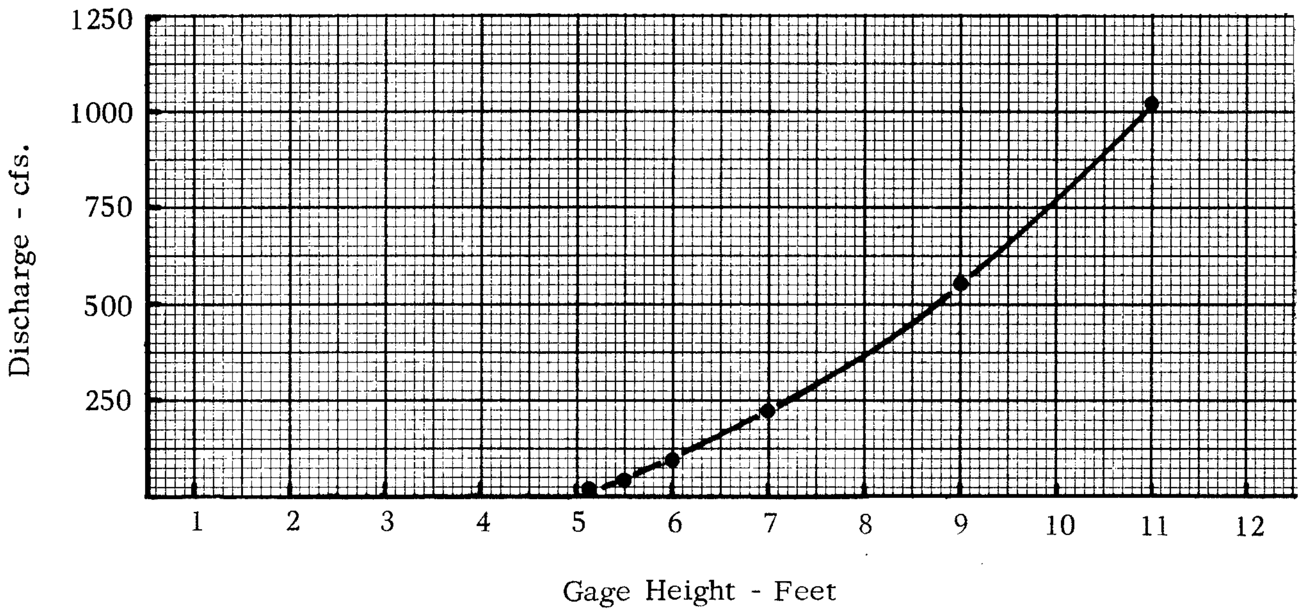
ORE CREEK NEAR BRIGHTON 6



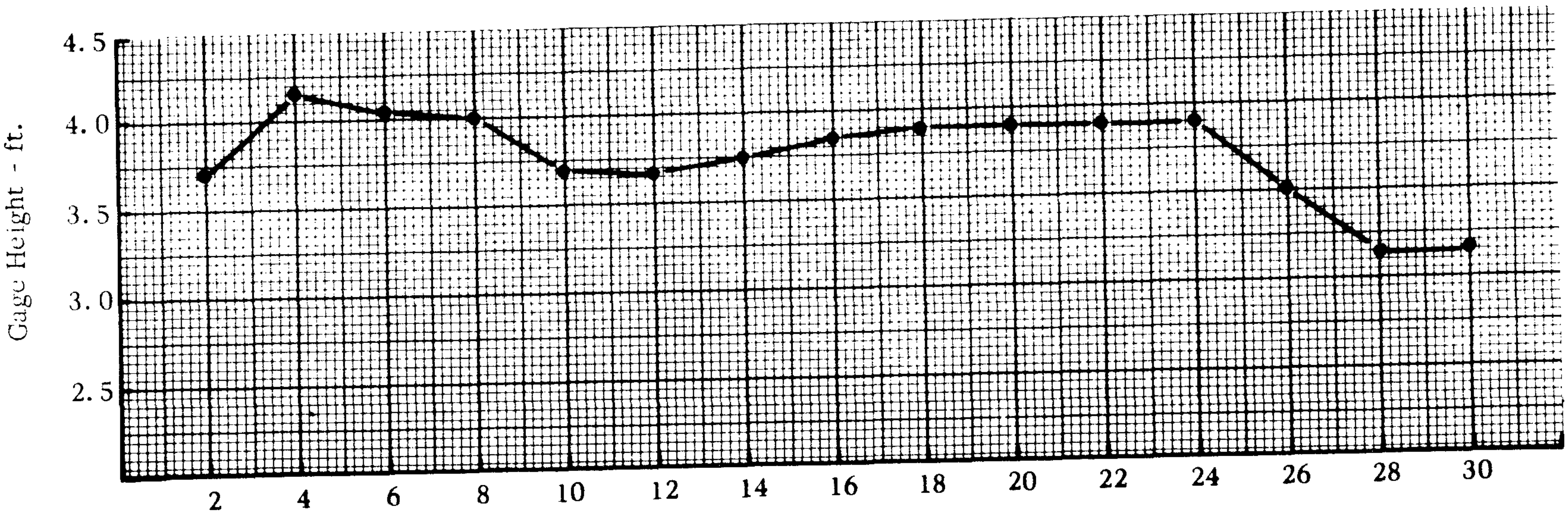
Maximum Gage Height (month of December, 1965)

MILL CREEK NEAR DEXTER 7



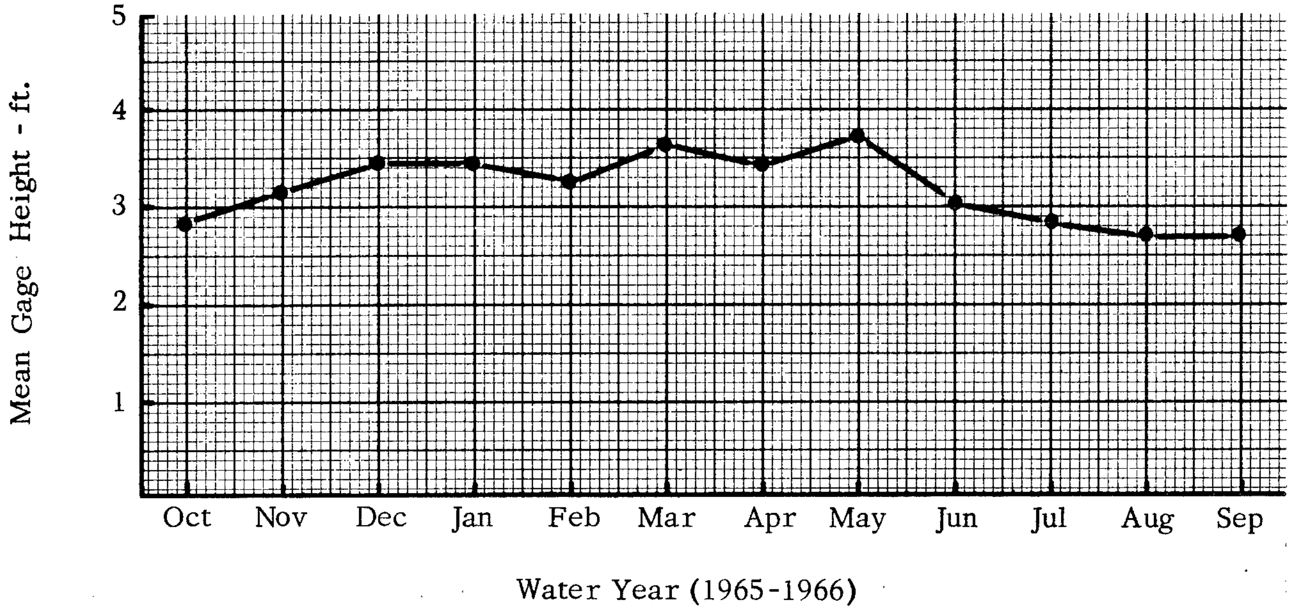


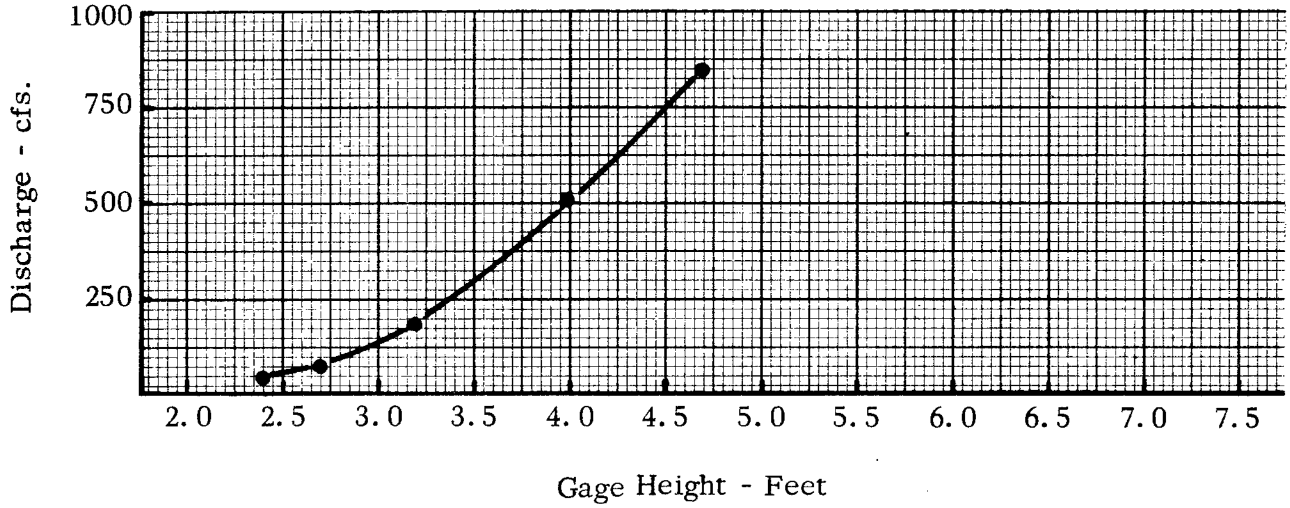
MILL CREEK NEAR DEXTER 7



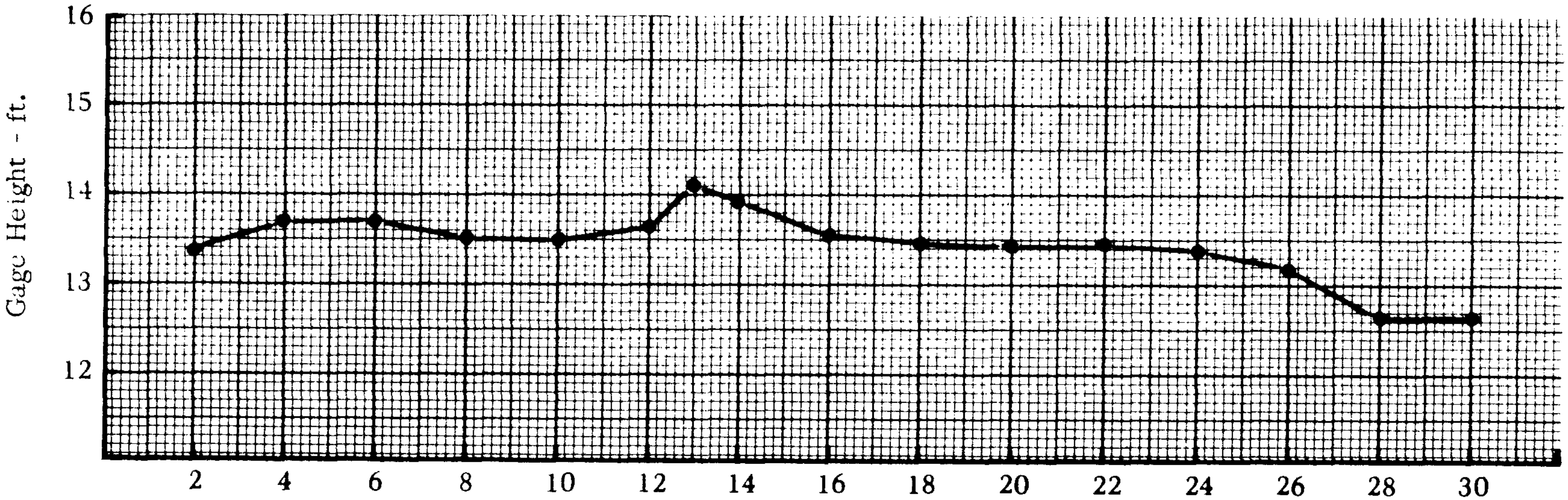
Maximum Gage Height (month of May, 1966)

HURON RIVER NEAR DEXTER 8



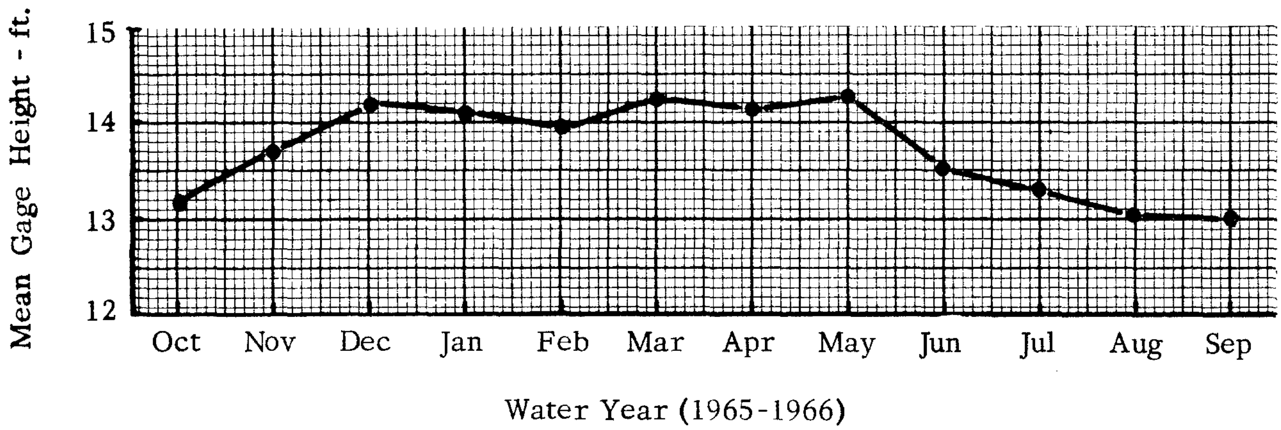


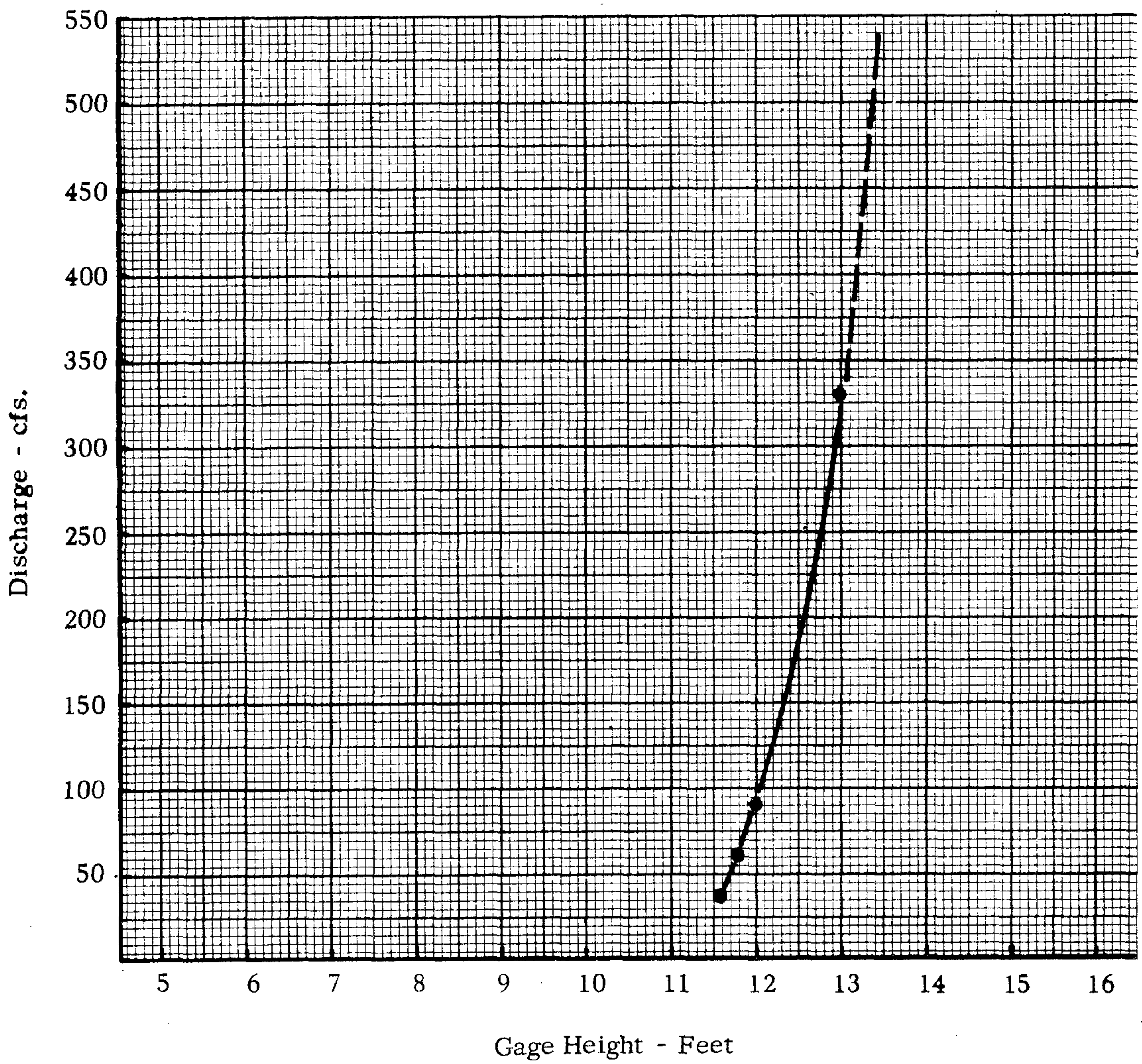
HURON RIVER NEAR DEXTER 8



Maximum Gage Height (month of May, 1966)

HURON RIVER AT ANN ARBOR 9





HURON RIVER AT ANN ARBOR 9

SUMMARY OF SITE DATA

BLACK RIVER

				LEFT BANK							RIGHT BANK						
Site No.	Max Stream Depth Ft.	Width of Stream Ft.	Width of Bank Ft.	Step Ft.	Angle O	Soil Measurements* N	P	L	C	F	Step Ft.	Angle O	Soil Measurements* N	P	L	C	F
1	1.0	62.7	82.7	0	23°						0	30°	___,	___,	___,	3.5,	17°
													___,	___,	___,	4,	13°
													___,	___,	___,	3,	22°
2	2.23	84.0	91.0	0	25°	___,	___,	___,	3,	4°	0	10°	___,	___,	___,	4,	35°
						___,	___,	___,	3,	25°			___,	___,	___,	3,	25°
3	2.7	115.0	131	2.5	10°	11.8%,	N.P.,	35.6%,	3.5,	33°	0	26°	8.45%,	N.P.,	13.5%	.5,	50°
						12.3%,	N.P.,	18.8%,	4.5,	18°							
4	1.8	79.5	97.0	0	15°	___,	___,	___,	2,	29°	2.5	10°	___,	___,	___,	.5,	40°
						___,	___,	___,	1,	30°			___,	___,	___,	1,	35°
5	1.03	67.7	92.8	0	10°	___,	___,	___,	0,	46°	0	8°	___,	___,	___,	3.5,	18°
						___,	___,	___,	2,	48°			___,	___,	___,	1.5,	35°
						___,	___,	___,	2,	41°							
6	0.86	73	87.1	0	11°	___,	___,	___,	0,	38°	1.5	12.5°	___,	___,	___,	1,	42°
													___,	___,	___,	2,	38°
7	1.13	53	75.1	0	9°	___,	___,	___,	0,	42°	1	23°	___,	___,	___,	5.5,	23°
						___,	___,	___,	4,	17°			___,	___,	___,	4,	36°
8	1.0	58.7	68.0	0	25°	___,	___,	___,	3,	27°	0	30°	___,	___,	___,	5,	39°
						___,	___,	___,	2,	45°			___,	___,	___,	5.5,	22°
						___,	___,	___,	1.5,	43°			___,	___,	___,	0,	45°
9	1.19	45.6	69.3	0	5°	___,	___,	___,	3,	16°	1.75	15°	___,	___,	___,	3,	28°
						___,	___,	___,	3,	16°			___,	___,	___,	1	53°
						___,	___,	___,	2.5,	14°			___,	___,	___,	2,	32°
10	1.86	52.9	71.3	0	12°	___,	___,	___,	3,	12°	0	8°	___,	___,	___,	2.5,	19°

*NOTE: N: natural water content, percent; P: plastic limit, percent; L: liquid limit, percent;
C: soil cohesion, psi.; F: angle of internal friction, degrees.

BLACK RIVER
(continued)

Site No.	Max. Stream Depth Ft.	Width of Stream Ft.	Width of Bank Ft.	LEFT BANK Step Ft.	LEFT BANK Angle O	LEFT BANK Soil Measurements N	P	L	C	F	RIGHT BANK Step Ft.	RIGHT BANK Angle O	RIGHT BANK Soil Measurements N	P	L	C	F
11	2.63	47	66.5	3	17°	___,	___,	___,	2,	45°	0	8°	___,	___,	___,	3,	0°
						___,	___,	___,	6,	42°			___,	___,	___,	4,	8°
12	2.34	126.5	148.4	0	45°	___,	___,	___,	2.5,	23°	0	8°	___,	___,	___,	3.5,	47°
						___,	___,	___,	3,	4°			___,	___,	___,	5,	14°
													___,	___,	___,	3,	4°
13	3.9	53.5	58.0	0	32°	5.3%,	N.P.,	22.8%,	5,	14°	0.5	20°	57.8%,	1.1%,	45.1%,	___,	___
14	3.25	86	90	2.5	8°	24.5%,	22.5%,	23.6%,	6.5,	28°	2	10°	___,	___,	___,	4.5,	25°
15	2.9	92.7	110.5	0	15°	39.7%,	N.P.,	___,	___,	___	0	35°	___,	___,	___,	2,	21°
						11.15%,	N.P.,	___,	___,	___							
71	2.16	61.7	73.7	1.5	5°	6.3%,	N.P.,	N.P.,	1,	18°	1	7.5°	6.4%,	N.P.,	N.P.,	2,	22°
													6.4%,	N.P.,	N.P.,	5,	25°
72	2.65	61	65.3	0	45°	0.0%,	N.P.,	N.P.,	0.0,	19°	0	40°	5.8%,	.7%,	15.2%,	2,	22°
73	1.0	72.6	113.6	0	15°	___,	___,	___,	.75,	46°	0	12.5°					
74	1.22	52.8	77.5	0	11°						0	5°	17.3%,	11.2%,	20%,	2.5,	50°
75	1.38	58.7	66.6	0	15°						0	8°	22.7%,	23%,	20%,	1,	51°
76	1.9	57.4	84.1	0	10°	___,	___,	___,	1.5,	43°	0	22°	11.4%,	N.P.,	N.P.,	2.5	33°
77	8.2	156.2	178.8	3.5	4°						0	60°					
78	8.6	123.6	123.6	4.5	2°	___,	___,	___,	4,	39°	1.5	38°					
79	8.5	119	119	4	0°	___,	___,	___,	1.5,	42°	1.2	23°	___,	___,	___,	3.5,	45°
						___,	___,	___,	0,	50°			___,	___,	___,	0,	41°
80	8.5	115.5	129.5	4	0°	___,	___,	___,	0,	41°	1.5	12°	___,	___,	___,	0	45°
													___,	___,	___,	.5	42°
81	1.95	37.1	52.7	0	16°	___,	___,	___,	0	45°	0	42.5°	___,	___,	___,	0	40°
82	1.62	34.2	65.5	0	60°						0	60°	___,	___,	___,	2	23°

SUMMARY OF SITE DATA

HURON RIVER

Site No.	Max Stream Depth Ft.	Width of Stream Ft.	Width of Bank Ft.	LEFT BANK Step Ft.	Angle O	Soil Measurements N	P	L	C	F	RIGHT BANK Step Ft.	Angle O	Soil Measurements N	P	L	C	F
16	1.6	103.0	108.5	0	10°	52.6%,	26.8%,	42.3%,	___,	___	0	30°	___,	___,	___,	6,	20°
									3.5,	35°			48.6%,	N.P.,	27%,	___,	___
						___,	___,	___,									
						34.8%	N.P.,	___,	___,	___							
17	2.34	88.5	93.6	0	15°	57.9%,	N.P.,	N.P.,	5,	20°	0	12°	53%,	N.P.,	19.8%,	7,	27°
18	3.58	108.4	115.5	2.5	24°	28%,	N.P.,	28.7%,	9,	23°	0	25°	___,	___,	___,	6,	44°
						14%,	N.P.,	23.1%,	___,	___							
19	4.15	180	181.3	0	10°	84%,	2.6%,	48.6%,	2,	34°	0	8°	166%,	N.P.,	76.8%,	7,	43°
20	2.85	199.8	201.1	0	17°	39.6%,	N.P.,	41%,	6,	37°	0.5	23°	11.4%,	N.P.,	31.1%,	6,	30°
21	4.42	121	197	0	3°	148%,	12%,	67.8%,	6,	28°	0	8°	123%,	7.2%,	67.8%,	2.5,	28°
22	1.84	117.5	128.5	0	35°	19%,	9%,	23%,	0,	54°	0	15°	52%,	10.3%,	37.9%,	2.5,	39°
23	2.70	134.7	178.8	0	12°	20.8%,	N.P.,	N.P.,	0,	50°	0	25°	N.P.,	N.P.,	N.P.,	4,	28°
24	2.75	127.5	141.7	0	10°	48%,	9%,	39%,	4,	35°	1	20°	24%,	N.P.,	29%,	1,	48°
25	3.89	133	144	0	10°	89%,	4.4%,	54%,	0,	43°	0	20°					
26	3.03	170	225.5	0	5°	91.4%,	1%,	81.8%,	2,	28°	0	15°	39.7%,	2.7%,	32.7%,	2.5,	22°
27	3.74	108.8	112.8	1.0	6°	56%,	.2%,	57%,	1,	56°	0	9°	45.1%,	6%,	45%,	4.5,	11°
28	2.14	165.5	172.5	0.5	15°	29%,	0.8%,	37%,	6,	30°	0	10°	115.8%,	3.4%,	70%,	1.5,	44°
29	2.55	141	146.0	0	25°	11.1%,	10.4%,	25.5%,	8,	37°	0	35°	79%,	N.P.,		4.5,	37°
30	2.42	103.2	104.2	.75	5°	95%,	11.6%,	N.P.,	5.5,	30°	0	7°	100.7%,	17%,	46%,	4,	35°
31	4.98	54.4	108.6	0	6°	65%,	13.5%,	28.7%,	2.5,	30°	1.5	22°	65.5%,	N.P.,	26%,	___,	___
						21.5%,	N.P.,	20.3%,	___,	___			0.5%,	N.P.,	N.P.,	1.5,	44°
32	1.44	97.5	114.5	1.0	1.5°	___,	___,	___,	4.5,	27°	0	5°	___,	___,	___,	8,	4°
33	7.60	179.5	194.2	.75	10°	38.5%,	N.P.,	20.7%,	3,	42°	0	12°	3.5%,	N.P.,	N.C.,	6.5,	3°
34	2.23	88.3	140.3	1	1°	69.8%,	6.8%,	39%,	1.5,	43°	0	23°	36.8%,	23.6%,	28%,	3.5,	41°

HURON RIVER
(continued)

Site No.	Max Stream Depth Ft.	Width of Stream Ft.	Width of Bank Ft.	LEFT BANK Step Ft.	Angle O	Soil Measurements N	P	L	C	F	RIGHT BANK Step Ft.	Angle O	Soil Measurements N	P	L	C	F
35	2.0	92.0	103.4	0	20°	4%,	23%,	25%,	3.5,	41°	2.5	8°	37%,	27%,	49.5%,	4.5,	36°
36	2.73	100.5	138.3	0	20°	16%,	N.P.,	48%,	4,	19°	0	18°	.3%,	3.7%,	8%,	5,	6°
37	3.0	103	146.8	0	25°	30.2%,	28.2%,	41.8%,	7,	36°	0	20°	4.6%,	N.P.,	N.P.,	4.5,	16°
						5.4%,	N.P.,	N.P.,	2,	3°							
38	2.95	103.2	144	0	18°						0	20°					
39	2.39	101.5	143	0	25°						0	18°					
40	1.36	95.3	110.8	0	20°	12.1%,	N.P.,	N.P.,	4.5,	7°	0	30°	___,	___,	___,	2.5,	37°
41	3.56	72.5	121.8	0	9°	7.7%,	9.2%,	23.8%,	3.5,	27	0	30°	___,	___,	___,	3.5,	27°
42	3.9	70.0	96.2	0	30°	5.2%,	N.P.,	N.P.,	1.5,	21°	0	17°	___,	___,	___,	4.5,	37°
													10.6%,	N.P.,	15.8%,	___,	___
43	3.6	75.0	97.1	0	30°	10.2%,	N.P.,	17.6%,	2,	34°	0	35°	6.3%,	N.P.,	13.3%,	3,	40°
44	1.53	96.0	105.4	3	20°	0.2%,	N.P.,	N.P.,	4,	10°	0	33°	___,	___,	___,	5,	29°
45	1.52	88.7	106.0	3.5	25°	5.3%,	7.3%,	21.3%,	2,	18°	0	23°	6.4%,	N.P.,	17.9%,	2,	29°
46	2.76	83.5	103.4	0	10°	31.2%,	N.P.,	30.6%,	5,	38°	0	24°	19.3%,	2.8%,	21.1%,	4,	39°
47	2.24	59.4	94.0	0	8°	30.8%,	N.P.,	25%,	2.6,	33°	0	24°	3.6%,	N.P.,	16%,	0,	46°
48	1.86	94.9	118.5	0	19°	5.5%,	N.P.,	17.9%,	1,	28°	0	25°	___,	___,	___,	3.5,	40°
49	1.29	100.4	125.5	0	37°	8.0%,	N.P.,	5.8%,	3,	16°	0	12°	6.3%,	N.P.,	17.8%,	3.5,	38°
50	1.35	86.0	120.7	0	8°	36.1%,	N.P.,	19.8%,	3,	29°	0	18°	___,	___,	___,	4,	44°
													18.6%,	N.P.,	24.1%,	___,	___
51	2.45	82	108.1	0	10°						0	26°					
52	3.62	79.8	105.3	0	20°						0	40°	16.3%,	N.P.,	24%,	2.5,	38°
53	3.90	74.0	98.2	.75	35°	19.5%,	N.P.,	14.9%,	0,	49°	0	16°	6.9%,	N.P.,	N.P.,	3.5,	15°
54	3.97	70.9	119.3	0	27°						0	12°	3.3%,	N.P.,	N.P.,	3.5,	0°

HURON RIVER
(continued)

Site No.	Max Stream Depth Ft.	Width of Stream Ft.	Width of Bank Ft.	LEFT BANK Step Ft.	Angle O	Soil Measurements N	P	L	C	F	RIGHT BANK Step Ft.	Angle O	Soil Measurements N	P	L	C	F
55	2.66	61.5	100.2	0	31°	___, 15.5%,	___, 4.2%,	___, 21.9%,	2, ___,	53° ___	0	18°	14.0%,	N.P.,	N.P.,	5,	25°
56	1.70	96.5	133.9	0	16°	37.4%,	9.4%,	20.5%,	___, 4,	___ 27°	0	15°	___, 4.3%,	___, N.P.,	___, N.P.,	7, ___,	25°
57	1.18	106.5	138.0	3	40°	___, 25.2%,	___, 9.3%,	___, 20.8%,	2.5,	37°	0	16°	2.8%,	N.P.,	N.P.,	1,	30°
58	2.36	88.5	109.4	0	35°	___,	___,	___,	4,	29°	0	32°				.5,	46°
59	2.96	84.6	92.1	0	12°						8.5	90°	___, 14.4%,	___, 2.7%,	___, 9.9%,	5,	21°
60	1.84	63.8	104.5	0	8°						10	90°	32.7%,	N.P.,	12.7%,	0,	45°
61	2.53	84.0	91.5	0	28°	15.7%,	N.P.,	N.P.,	0,	42°	5	24°	12%,	N.P.,	20.0%,	5,	43°
62	2.11	83.0	153.6	0	4°	38.9%,	N.P.,	N.P.,	3.5,	12°	0	20°	4.5%,	N.P.,	N.P.,	4,	35°
63	5.04	71.1	90.1	0	14°	4.6%,	N.P.,	N.P.,	1,	22°	0	33°	6.0%,	4.2%,	24%,	2,	45°
64	2.86	84.9	103.1	0	11°	7.5%,	1.1%,	12.5%,	.75,	27°	0	25°	15.5%,	N.P.,	13.11%,	5,	22°
65	4.60	88.7	117.5	0	26°	___,	___,	___,	3.5,	22°	0	24°	6.8%,	1.5%,	16.2%,	0,	35°
66	4.30	81.5	97.7	0	29°	1.0%,	N.P.,	N.P.,	2,	29°	0	30°					
67	2.95	124	144.5	0	8°	34.9%,	N.P.,	N.P.,	3,	22°,	0	28°					
68	3.65	94.5	118.4	0	20°	14.5%,	14%,	46.1%,	4,	41°	1	34°	3.6%,	4.3%,	24.8%,	3.5,	36°
69	3.28	123	127	0	25°	11.9%,	25.7%,	47%,	0,	41°	6.5	0°	8.7%,	N.P.,	11.8%,		43°
70	2.75	124	143.2	0	20°						0	60°	16%.	18.6%,	46.8%,	1,	38°

EXPLANATION OF SITE DATA

1. Arrows show approximate point at which soil data was obtained.

2. The numbers at the tail of each arrow show:

   a. natural water content, percent (N)
   b. plastic limit, percent (P)
   c. liquid limit, percent (L)
   d. soil cohesion, psi. (C)
   e. angle of internal friction - degrees (F)

   and are arranged in the following positions:

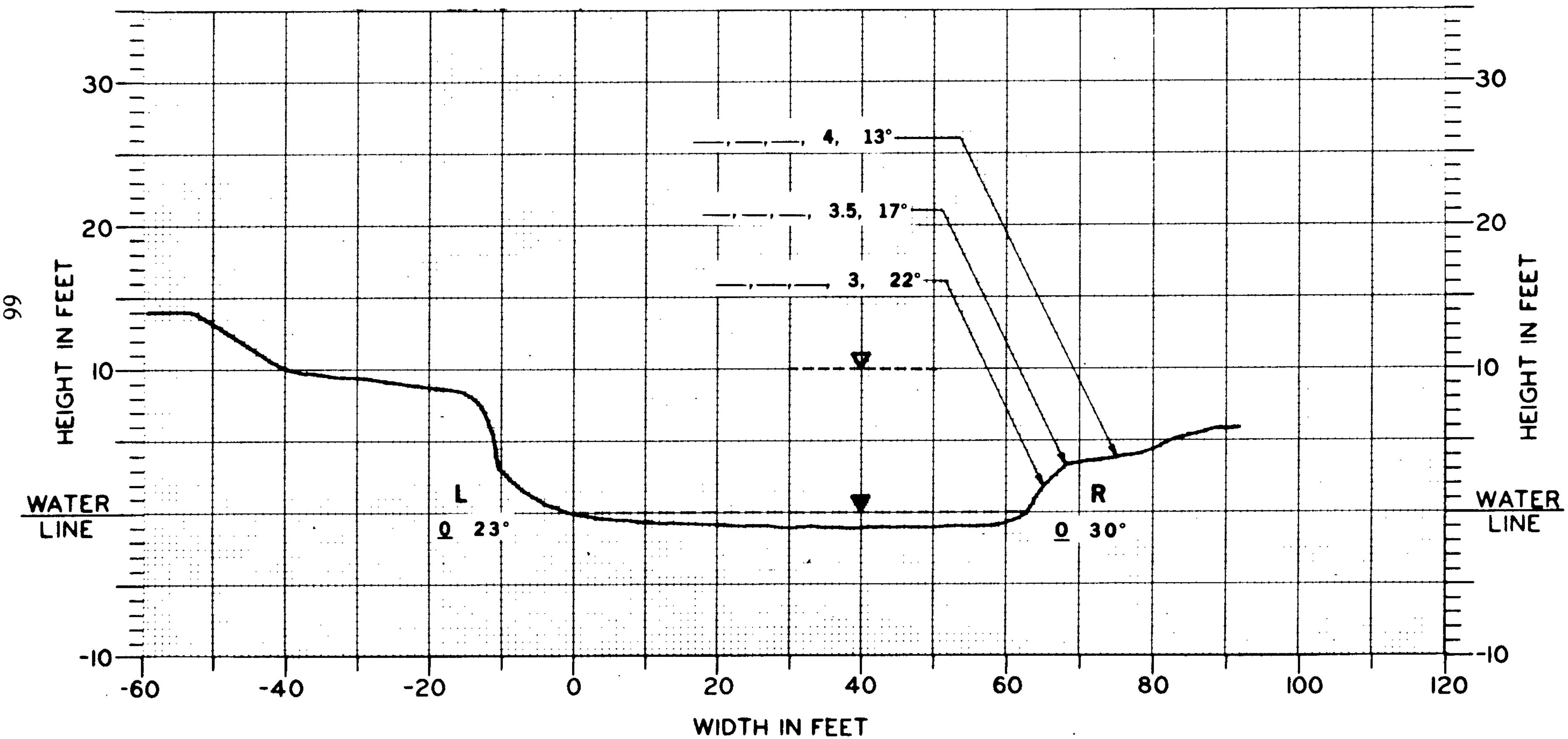
   N , P , L , C , F

3. When values were not determined, blank spaces have been left.

SITE NO. 1

BLACK RIVER

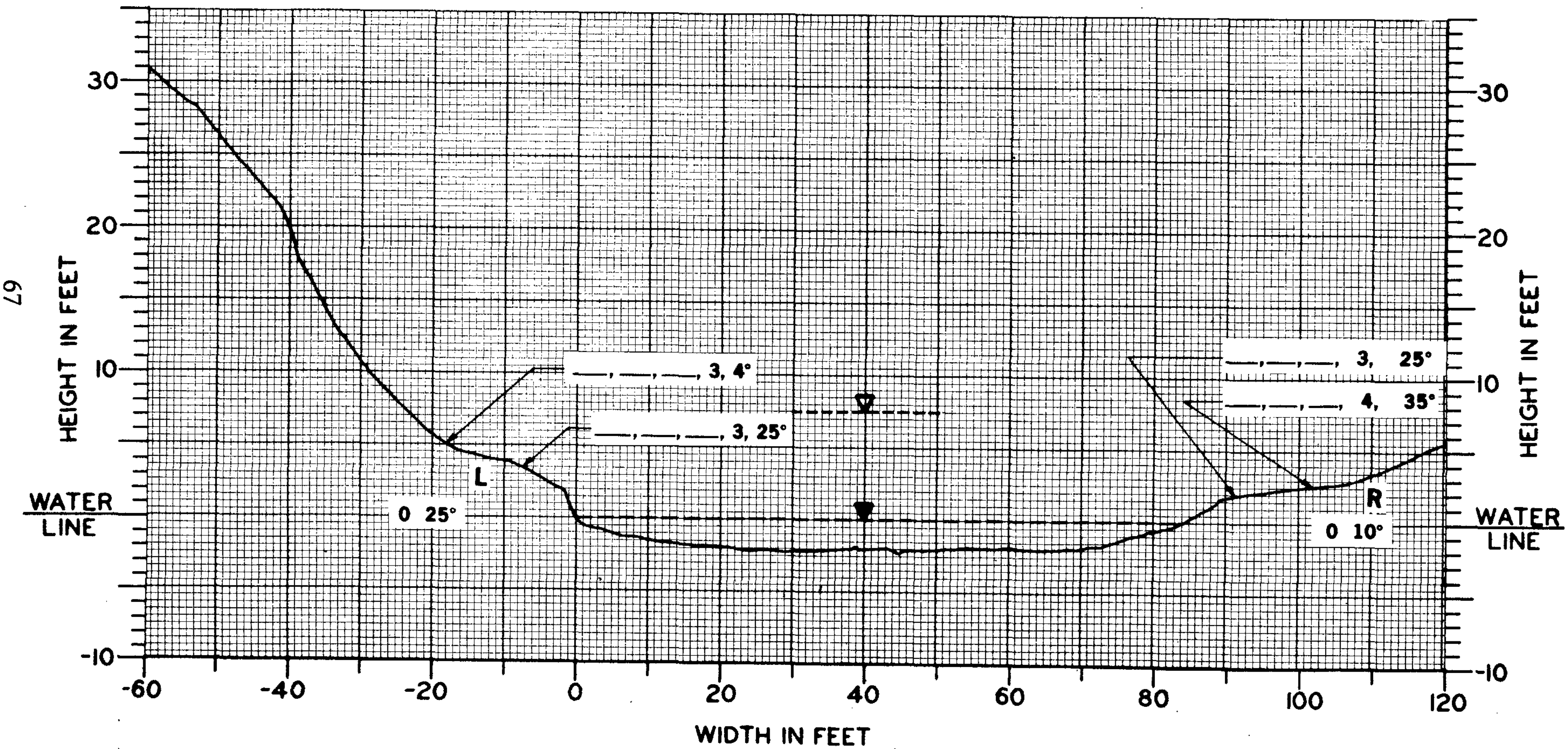
WIDTH OF STREAM (W-W) = 62.7 FT.
WIDTH OF BANKS (B-B) = 82.7 FT.
MEASURED DEPTH = 1.0 FT.



SITE NO. 2

BLACK RIVER

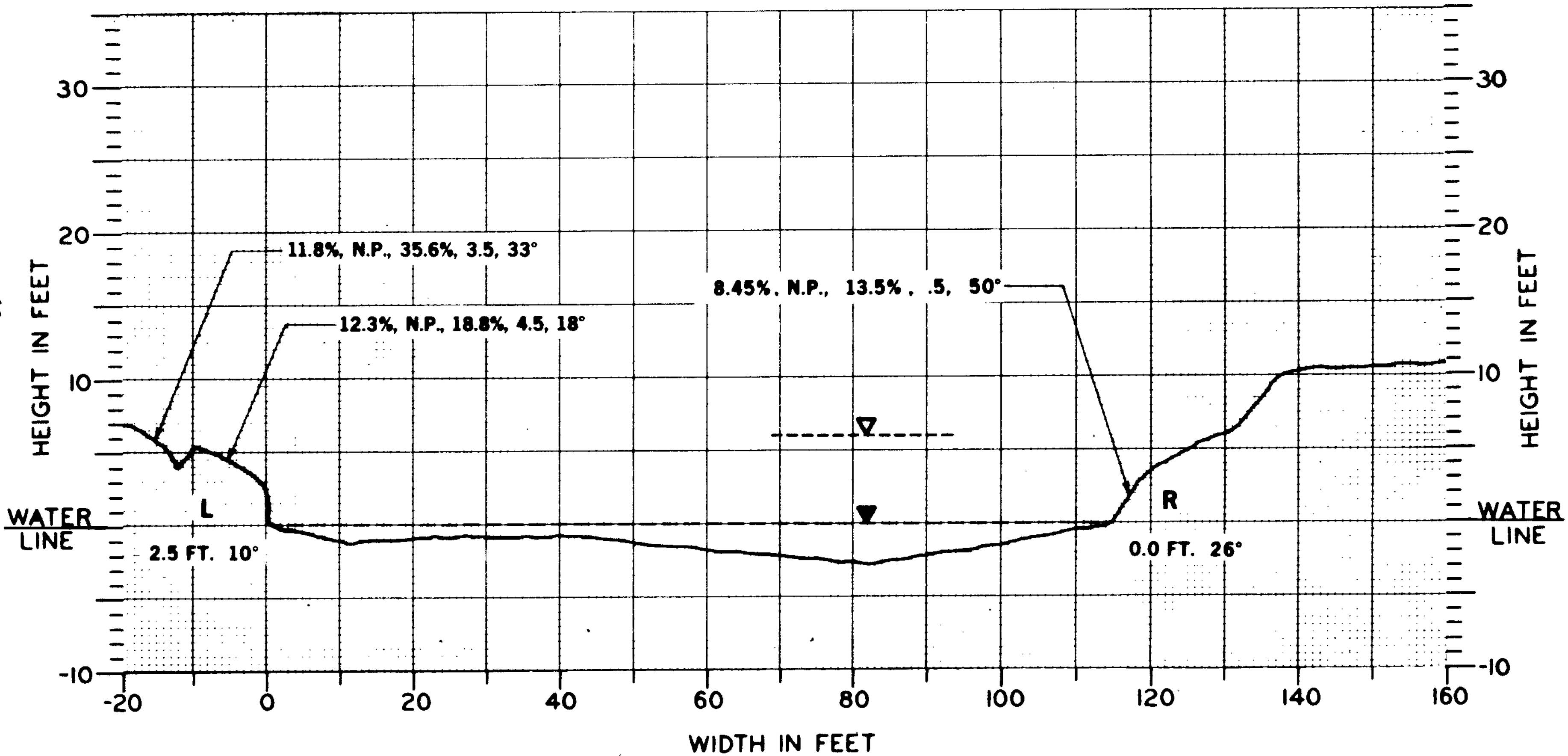
WIDTH OF STREAM (W-W) = 84.0 FT.
WIDTH OF BANKS (B-B) = 91.0 FT.
MEASURED DEPTH = 2.23 FT.



SITE NO. 3

BLACK RIVER

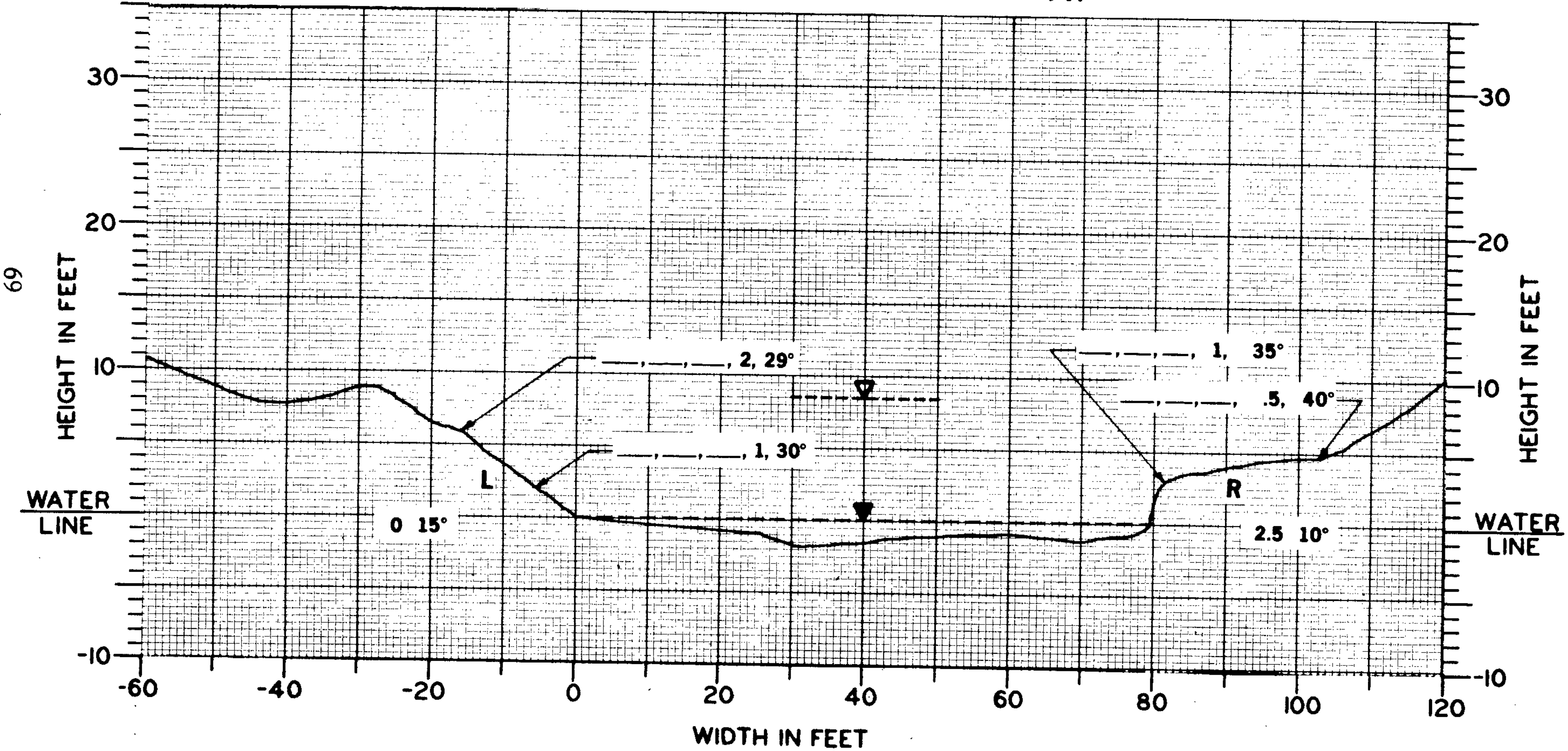
WIDTH OF STREAM (W-W) = 115 FT.
WIDTH OF BANKS (B-B) = 131 FT.
MEASURED DEPTH = 2.7 FT.



SITE NO. 4

BLACK RIVER

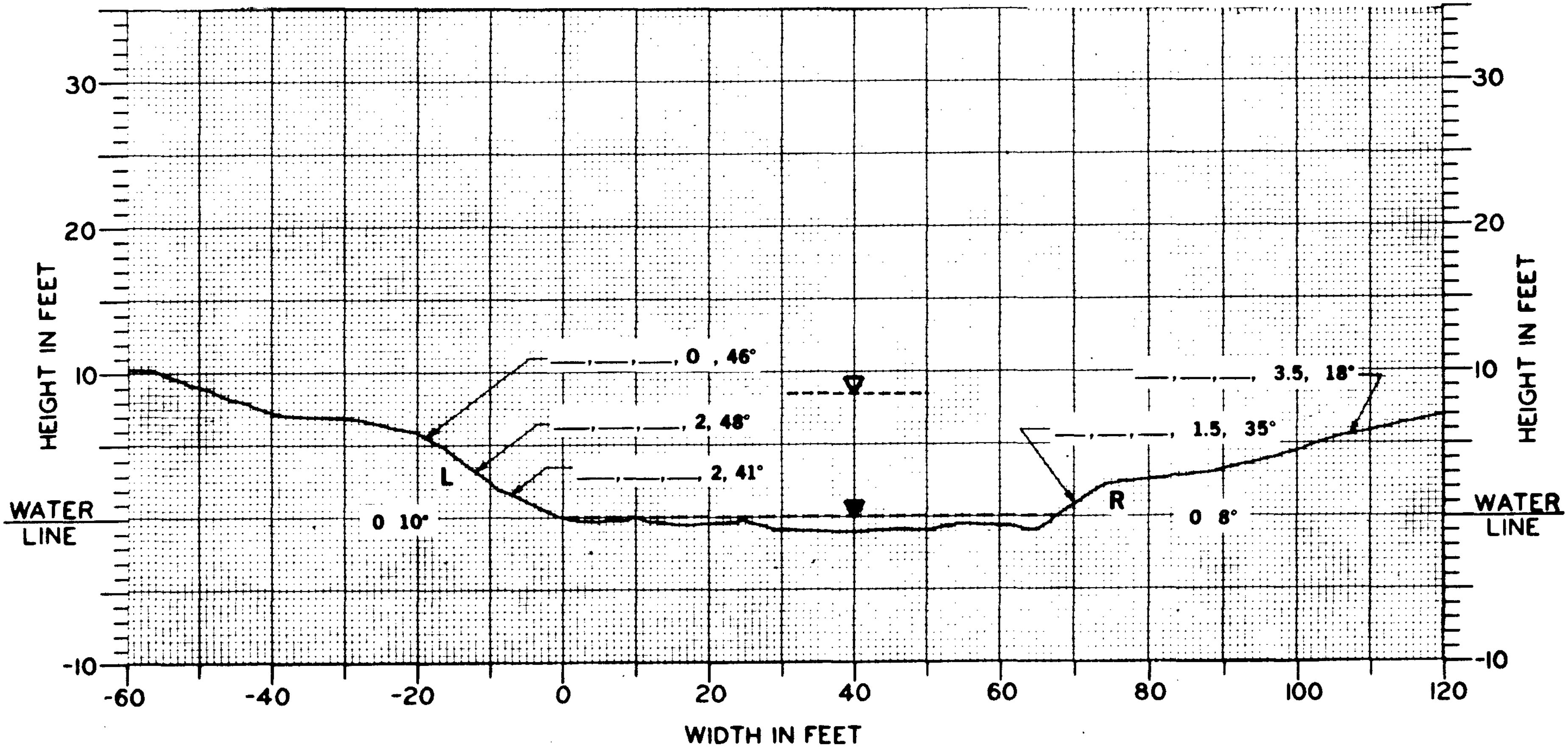
WIDTH OF STREAM (W-W) = 79.5 FT.
WIDTH OF BANKS (B-B) = 97.0 FT.
MEASURED DEPTH = 1.8 FT.



SITE NO. 5

BLACK RIVER

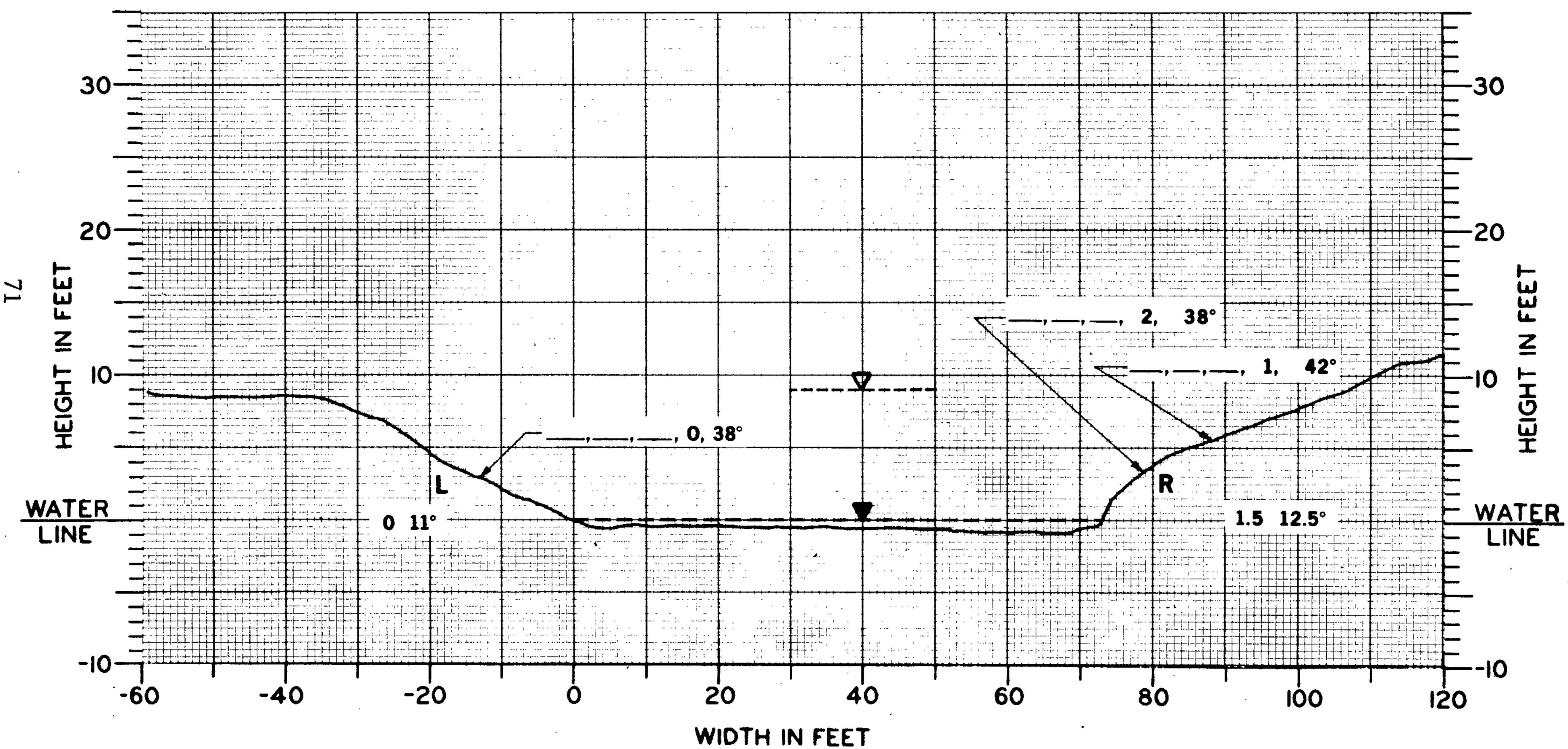
WIDTH OF STREAM (W-W) = 67.7 FT.
WIDTH OF BANKS (B-B) = 92.8 FT.
MEASURED DEPTH = 1.03 FT.



SITE NO. 6

BLACK RIVER

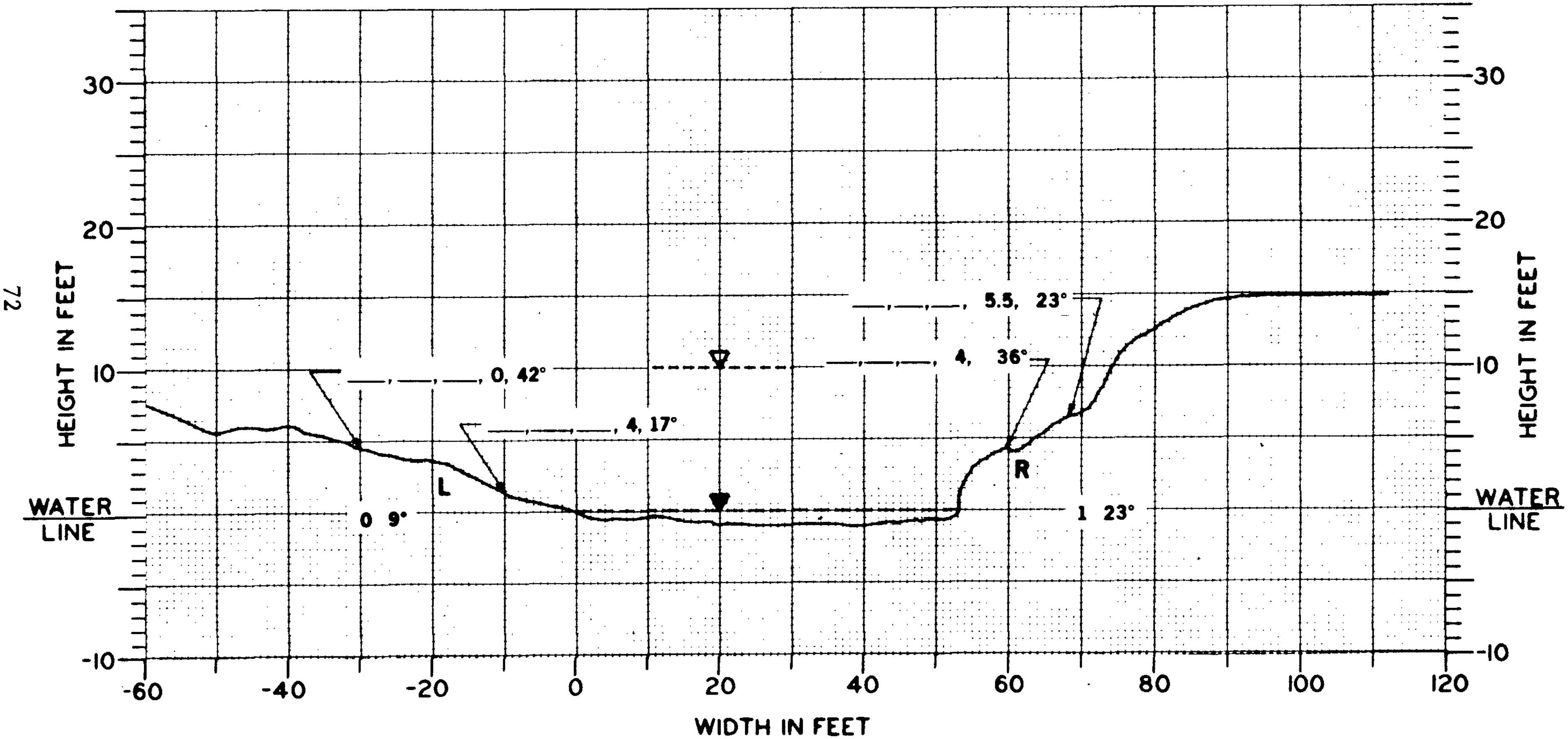
WIDTH OF STREAM (W-W) = 73 FT.
WIDTH OF BANKS (B-B) = 87.1 FT.
MEASURED DEPTH = 0.86 FT.



SITE NO. 7

BLACK RIVER

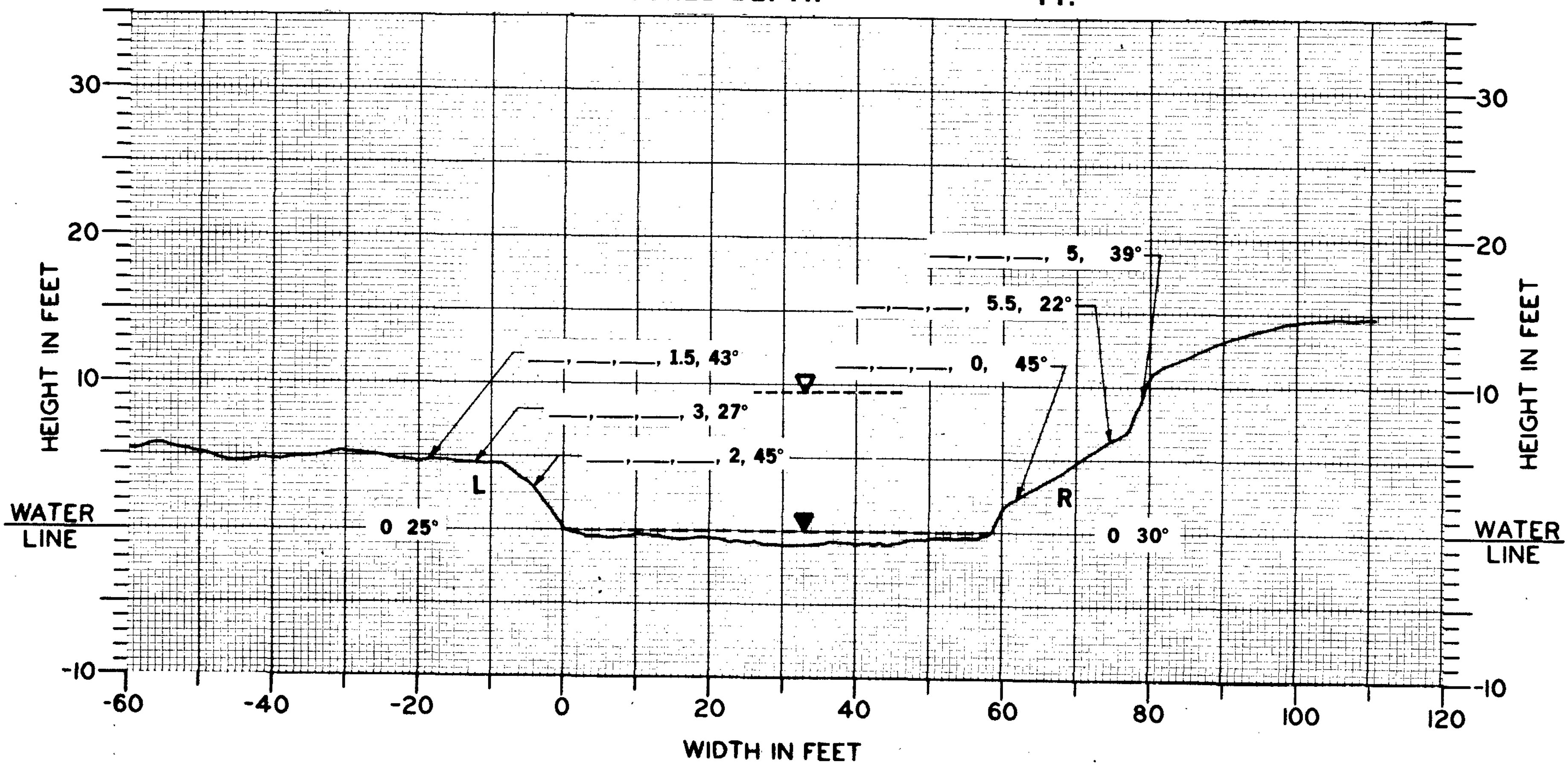
WIDTH OF STREAM (W-W) = 53 FT.
WIDTH OF BANKS (B-B) = 75.1 FT.
MEASURED DEPTH = 1.13 FT.



SITE NO. 8

BLACK RIVER

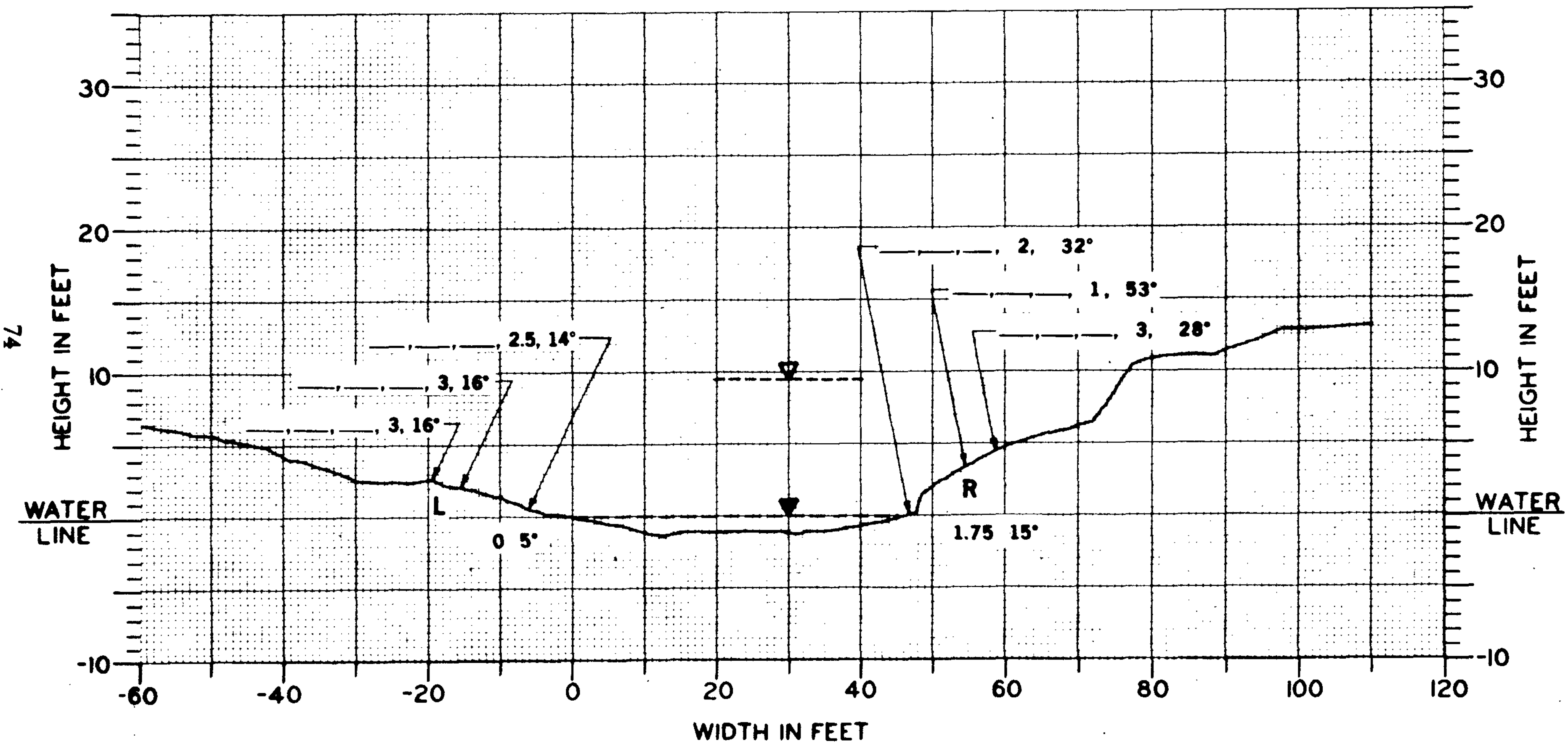
WIDTH OF STREAM (W-W) = 58.7 FT.
WIDTH OF BANKS (B-B) = 68.0 FT.
MEASURED DEPTH = 1.0 FT.



SITE NO. 9

BLACK RIVER

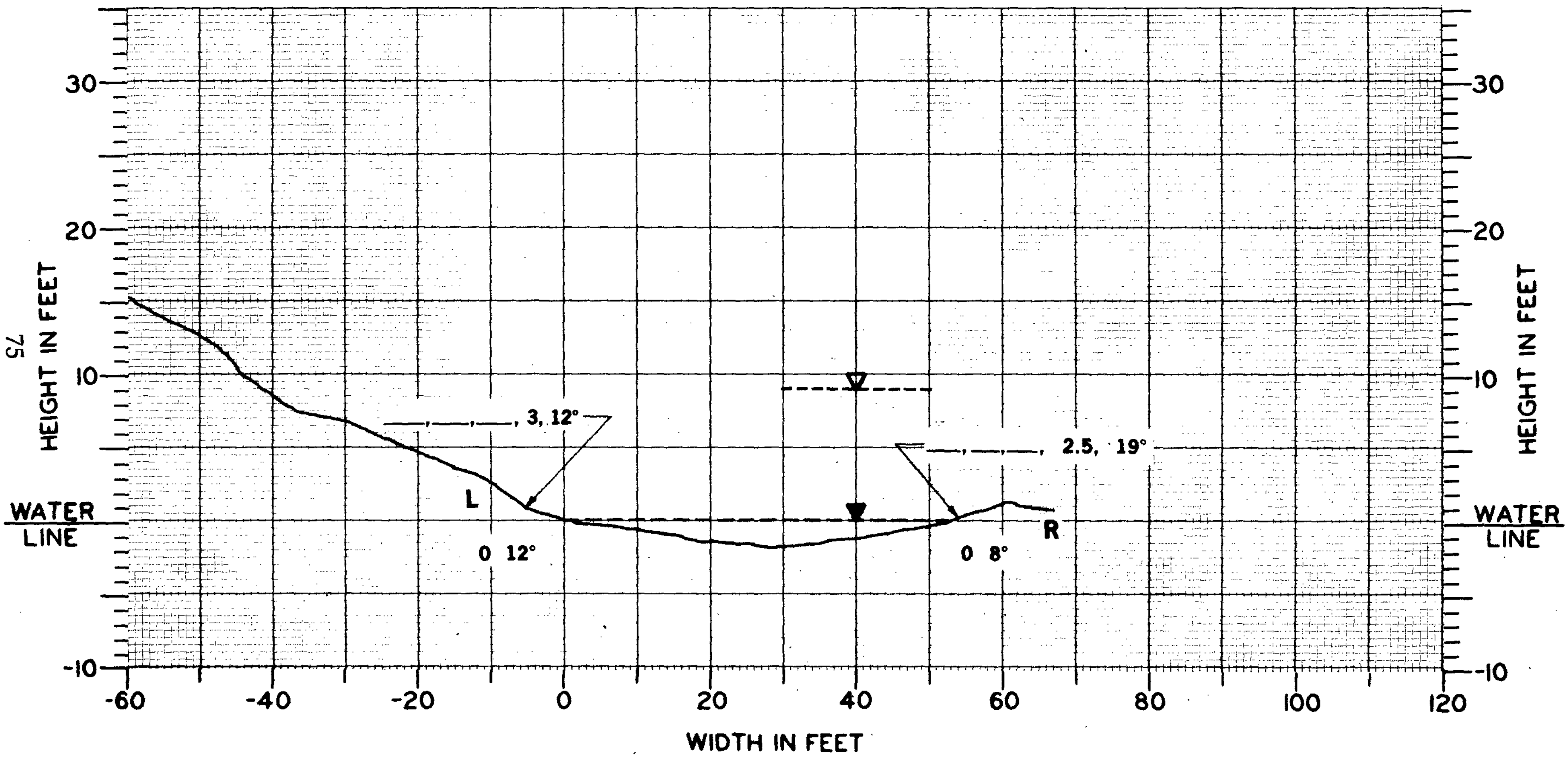
WIDTH OF STREAM (W-W) = 45.6 FT.
WIDTH OF BANKS (B-B) = 69.3 FT.
MEASURED DEPTH = 1.19 FT.



SITE NO. 10

BLACK RIVER

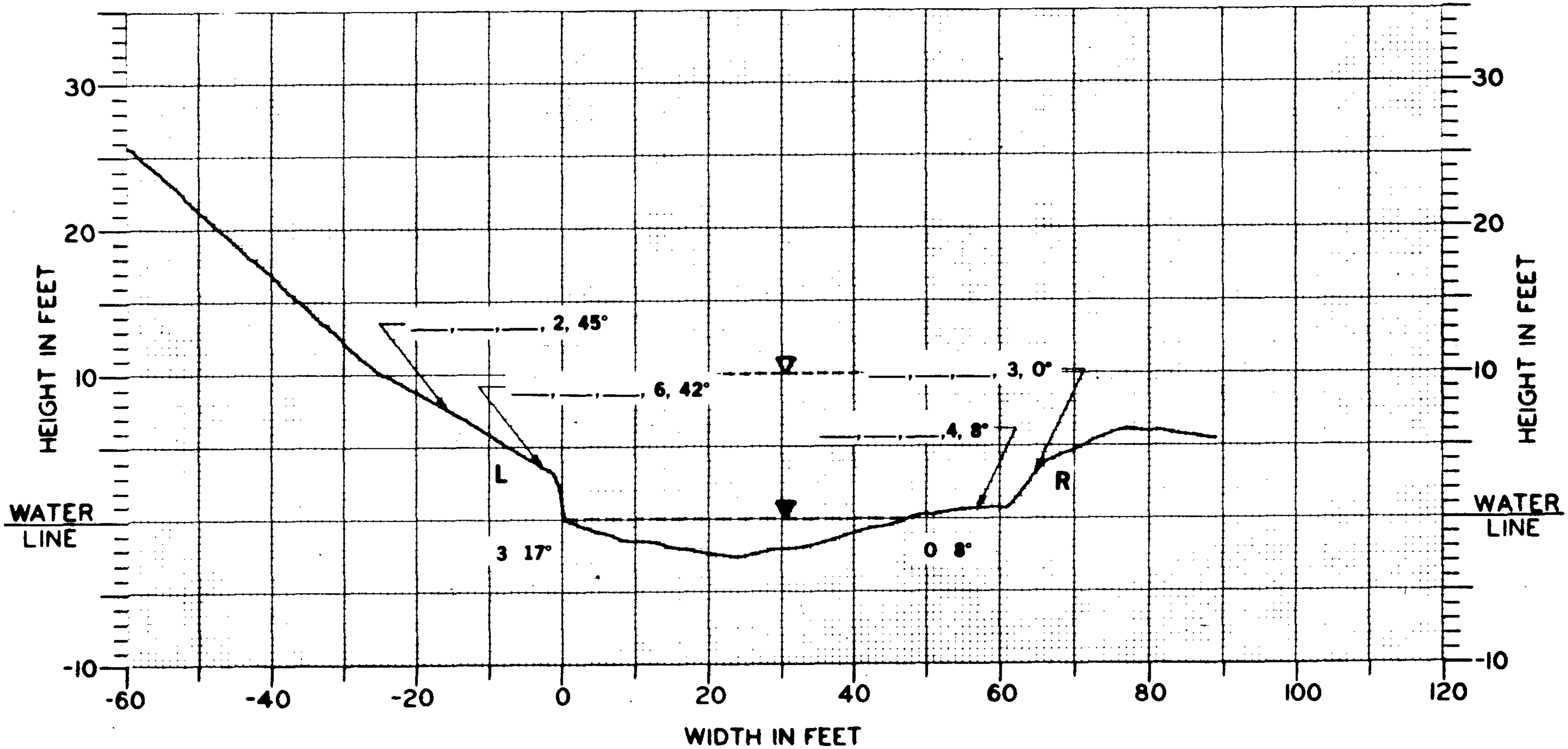
WIDTH OF STREAM (W-W) = 52.9 FT.
WIDTH OF BANKS (B-B) = 71.3 FT.
MEASURED DEPTH = 1.86 FT.



SITE NO. 11

BLACK RIVER

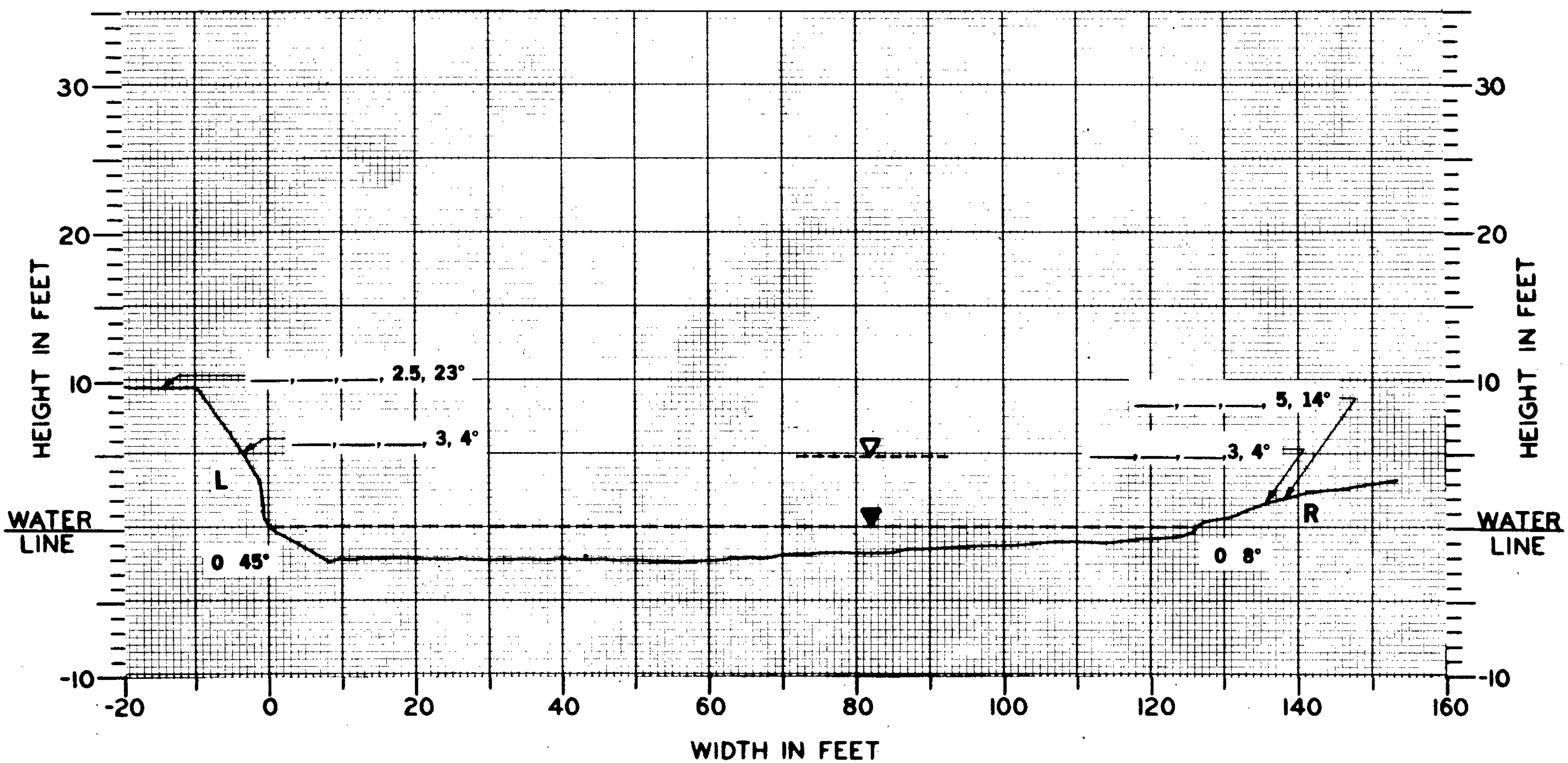
WIDTH OF STREAM (W-W) = 47 FT.
WIDTH OF BANKS (B-B) = 66.5 FT.
MEASURED DEPTH = 2.63 FT.



SITE NO. 12

BLACK RIVER

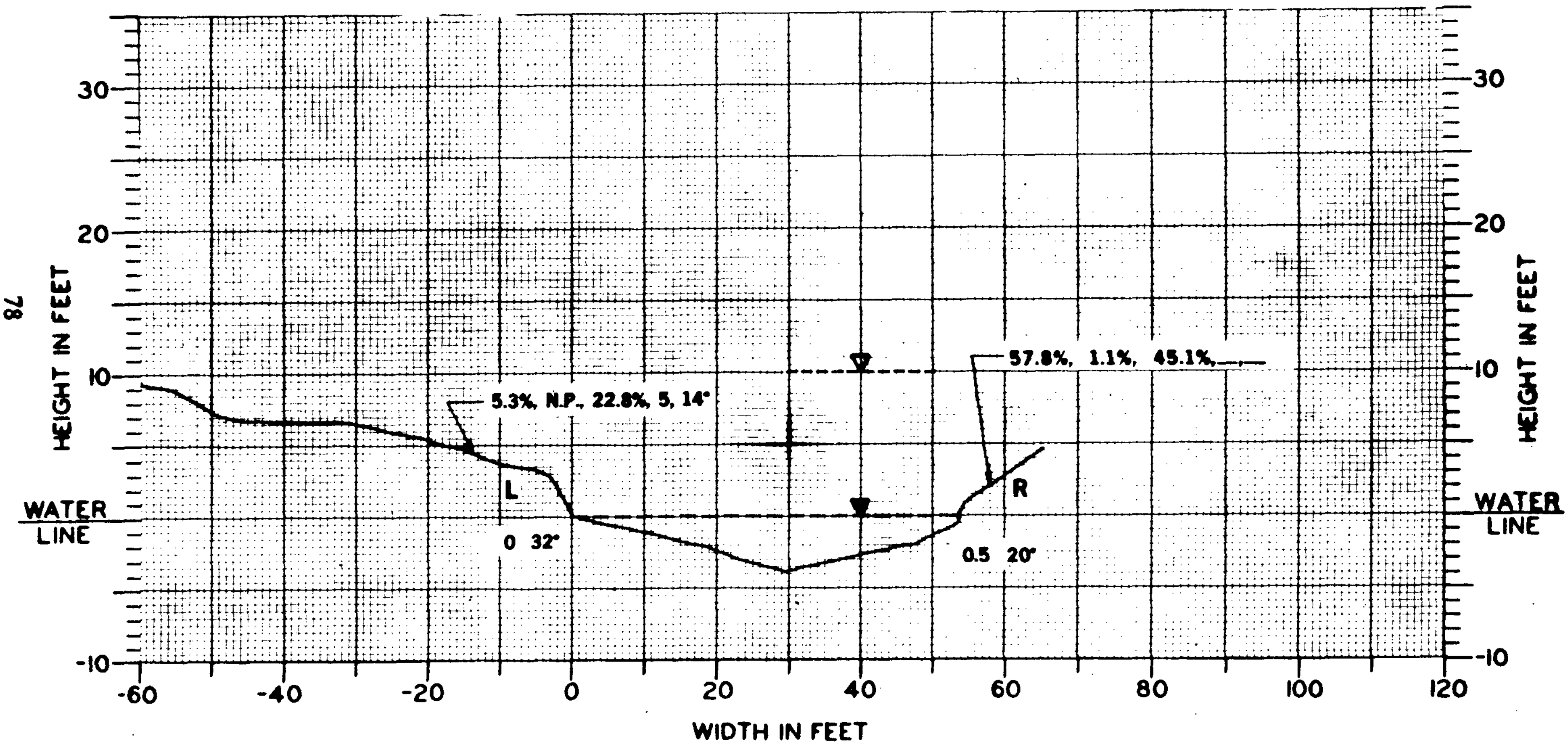
WIDTH OF STREAM (W-W) = 126.5 FT.
WIDTH OF BANKS (B-B) = 148.4 FT.
MEASURED DEPTH = 2.34 FT.



SITE NO. 13

BLACK RIVER

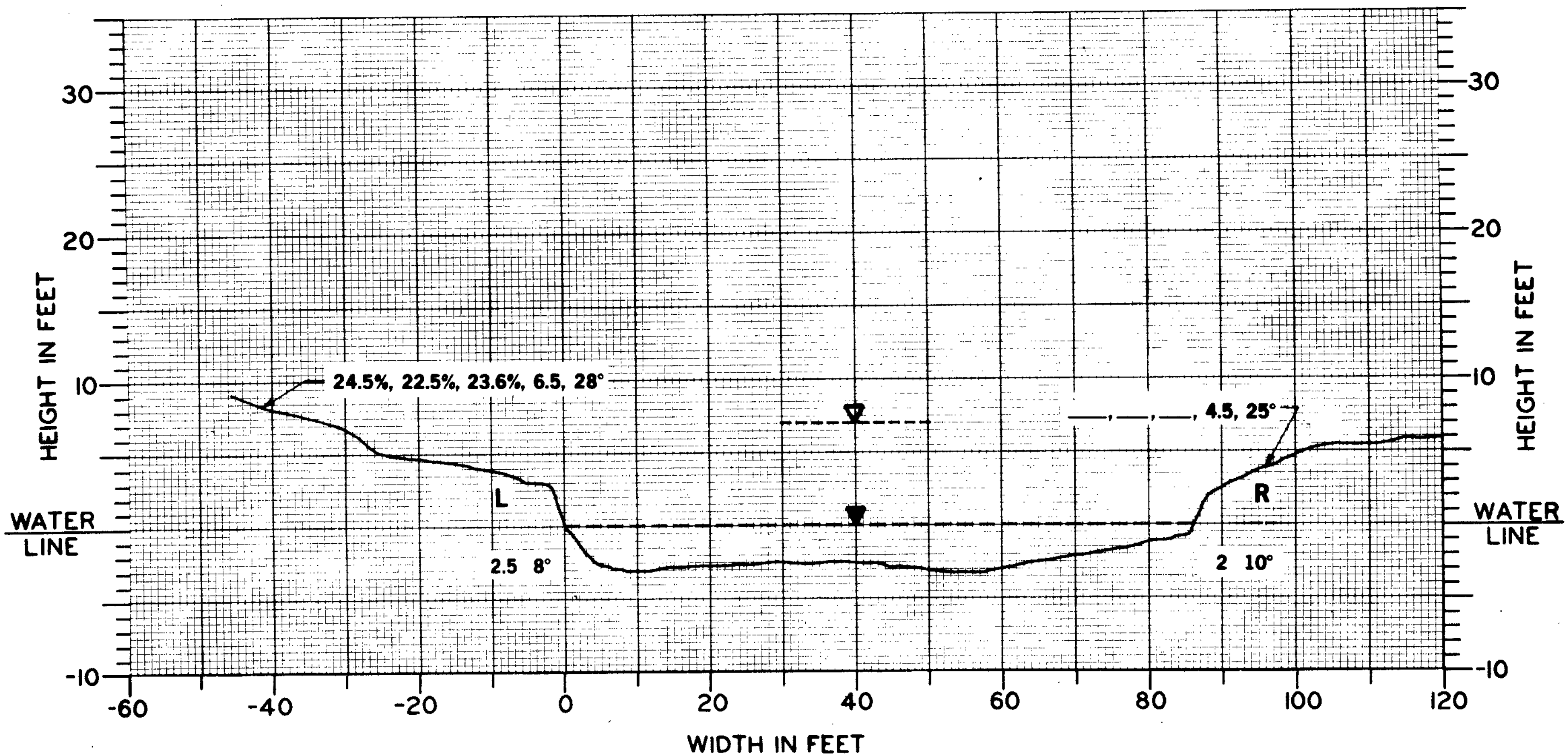
WIDTH OF STREAM (W-W) = 53.5 FT.
WIDTH OF BANKS (B-B) = 58.0 FT.
MEASURED DEPTH = 3.9 FT.



SITE NO. 14

BLACK RIVER

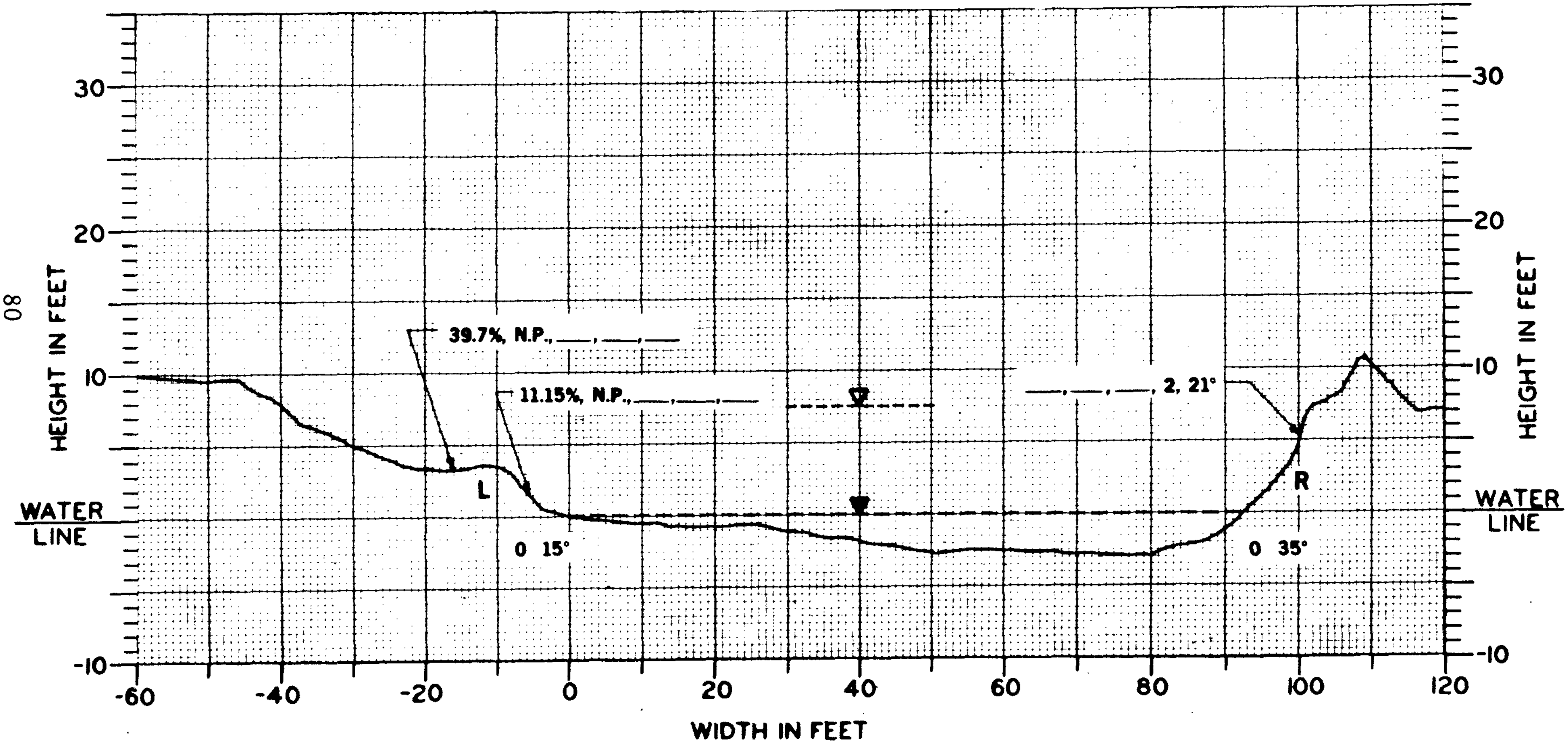
WIDTH OF STREAM (W-W) = 86 FT.
WIDTH OF BANKS (B-B) = 90 FT.
MEASURED DEPTH = 3.25 FT.



SITE NO. 15

BLACK RIVER

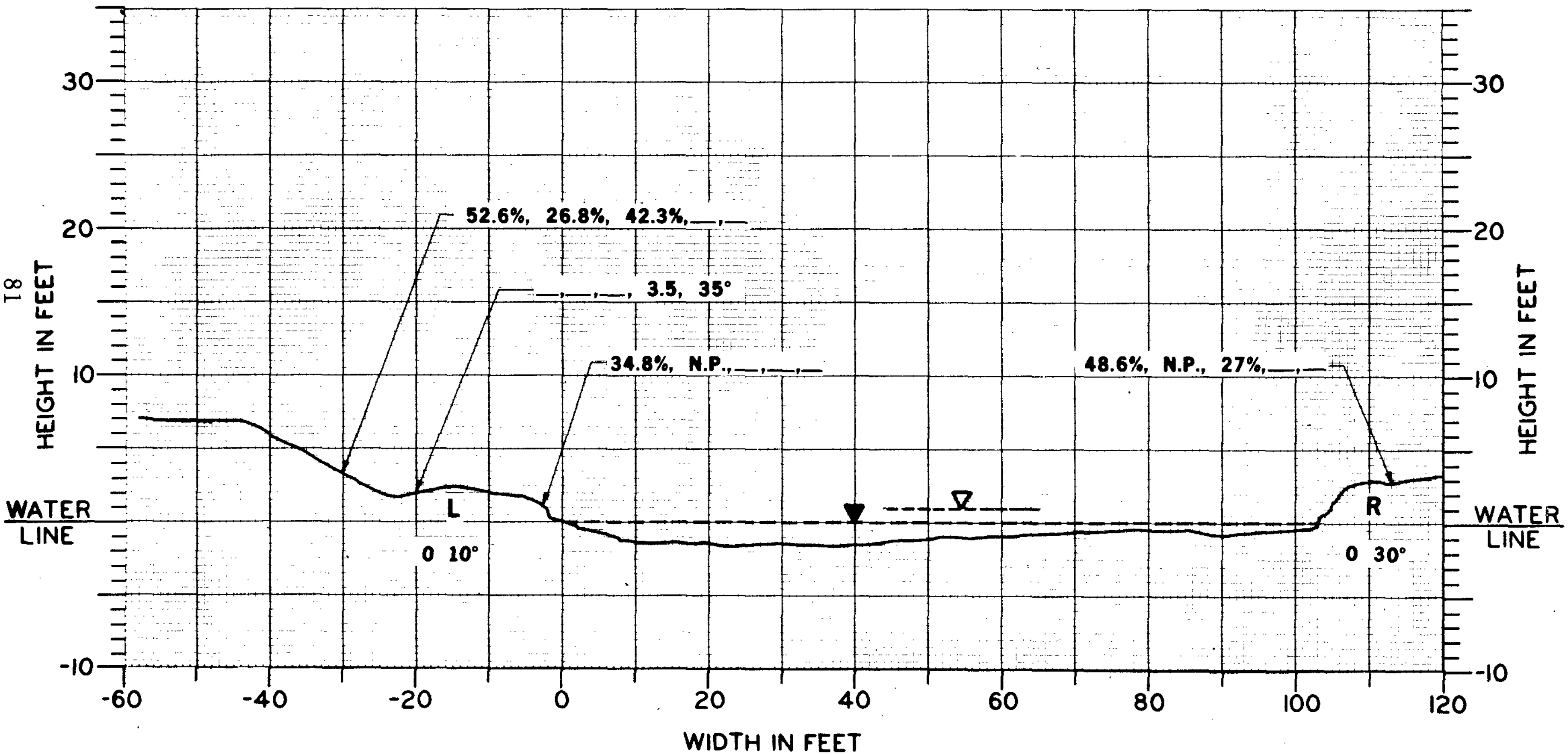
WIDTH OF STREAM (W-W) = 92.7 FT.
WIDTH OF BANKS (B-B) = 110.5 FT.
MEASURED DEPTH = 2.9 FT.



SITE NO. 16

HURON RIVER

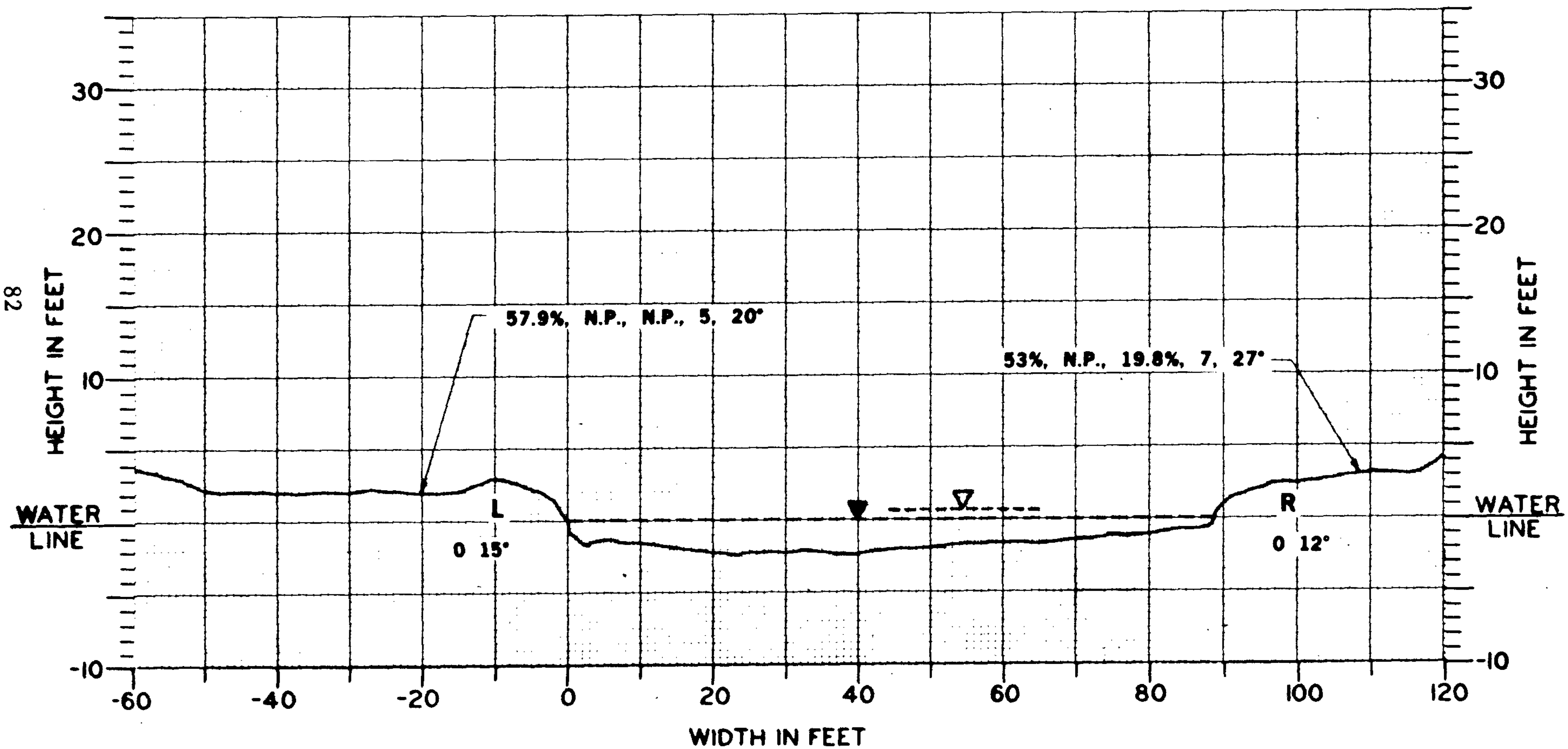
WIDTH OF STREAM (W-W) = 103.0 FT.
WIDTH OF BANKS (B-B) = 108.5 FT.
MEASURED DEPTH = 1.6 FT.



SITE NO. 17

HURON RIVER

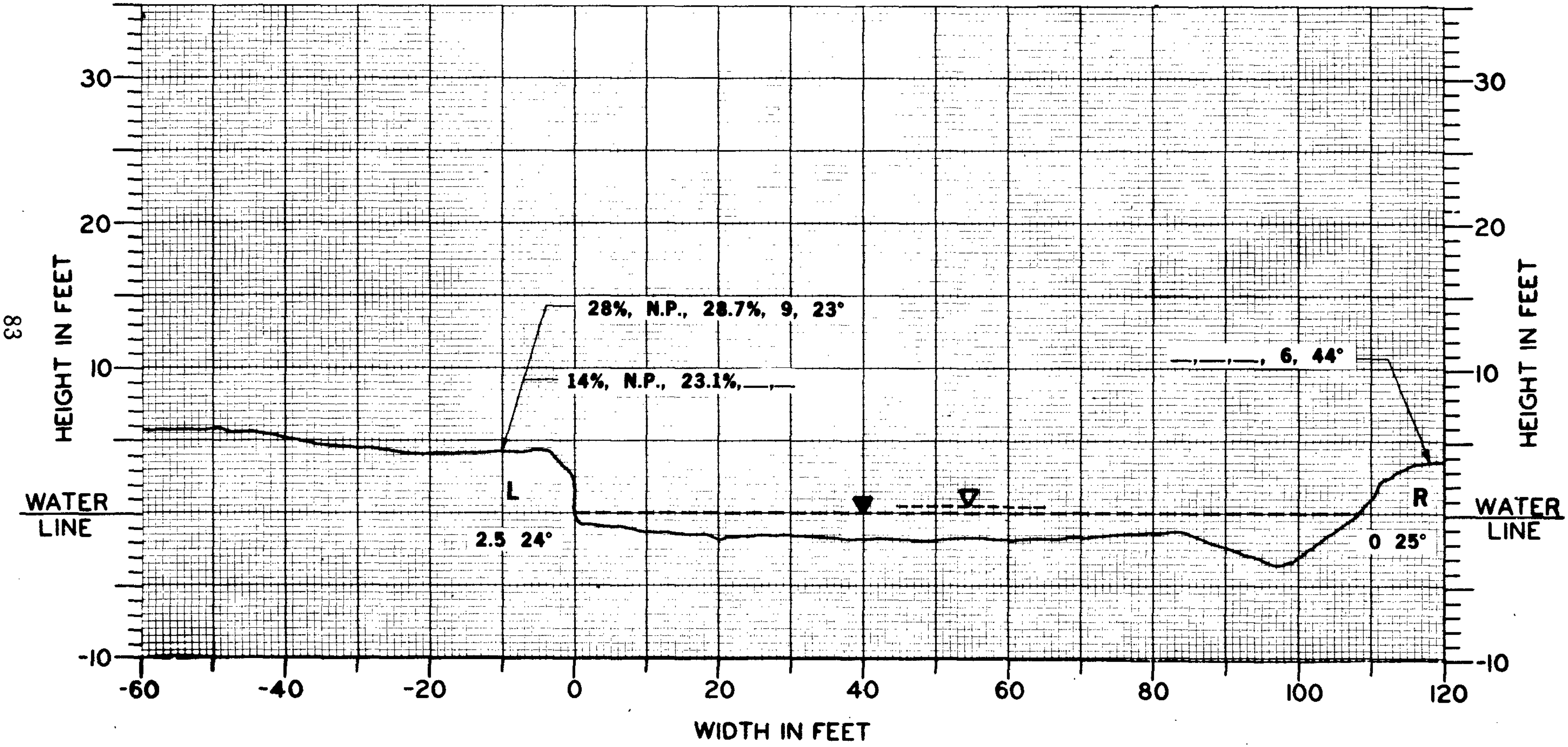
WIDTH OF STREAM (W-W) = 88.5 FT.
WIDTH OF BANKS (B-B) = 93.6 FT.
MEASURED DEPTH = 2.34 FT.



SITE NO. 18

HURON RIVER

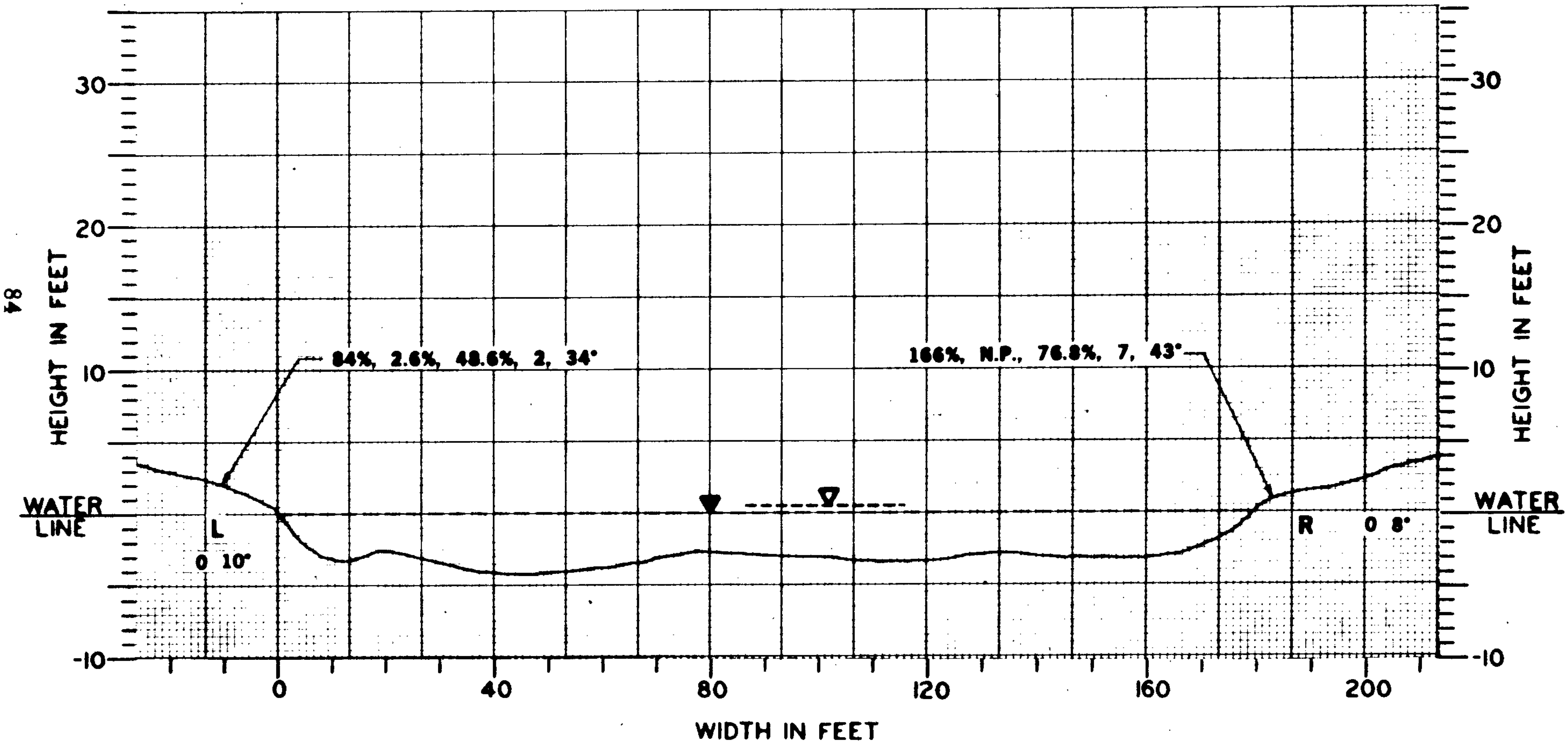
WIDTH OF STREAM (W-W) = 108.4 FT.
WIDTH OF BANKS (B-B) = 115.5 FT.
MEASURED DEPTH = 3.58 FT.



SITE NO. 19

HURON RIVER

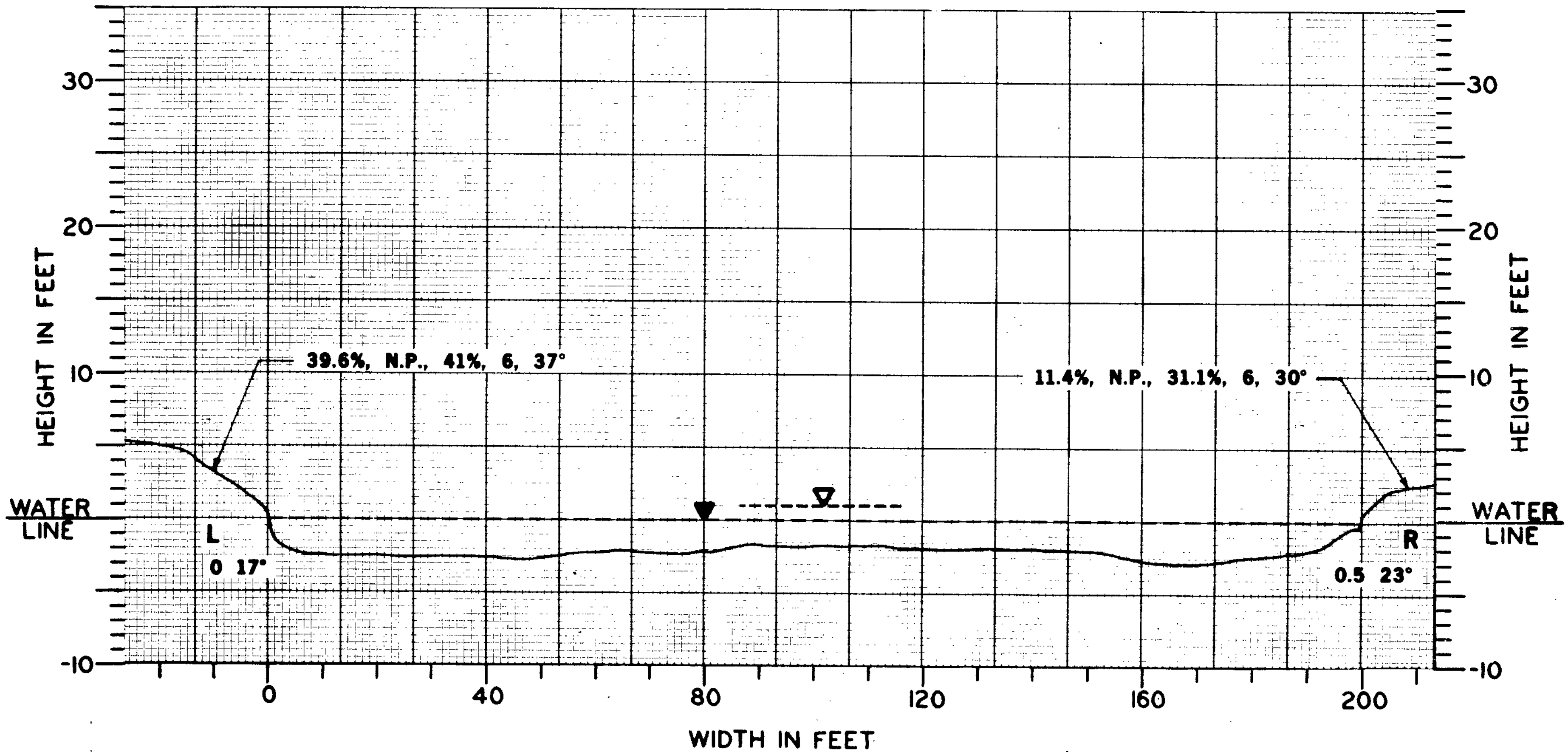
WIDTH OF STREAM (W-W) = 180 FT.
WIDTH OF BANKS (B-B) = 181.3 FT.
MEASURED DEPTH = 4.15 FT.



SITE NO. 20

HURON RIVER

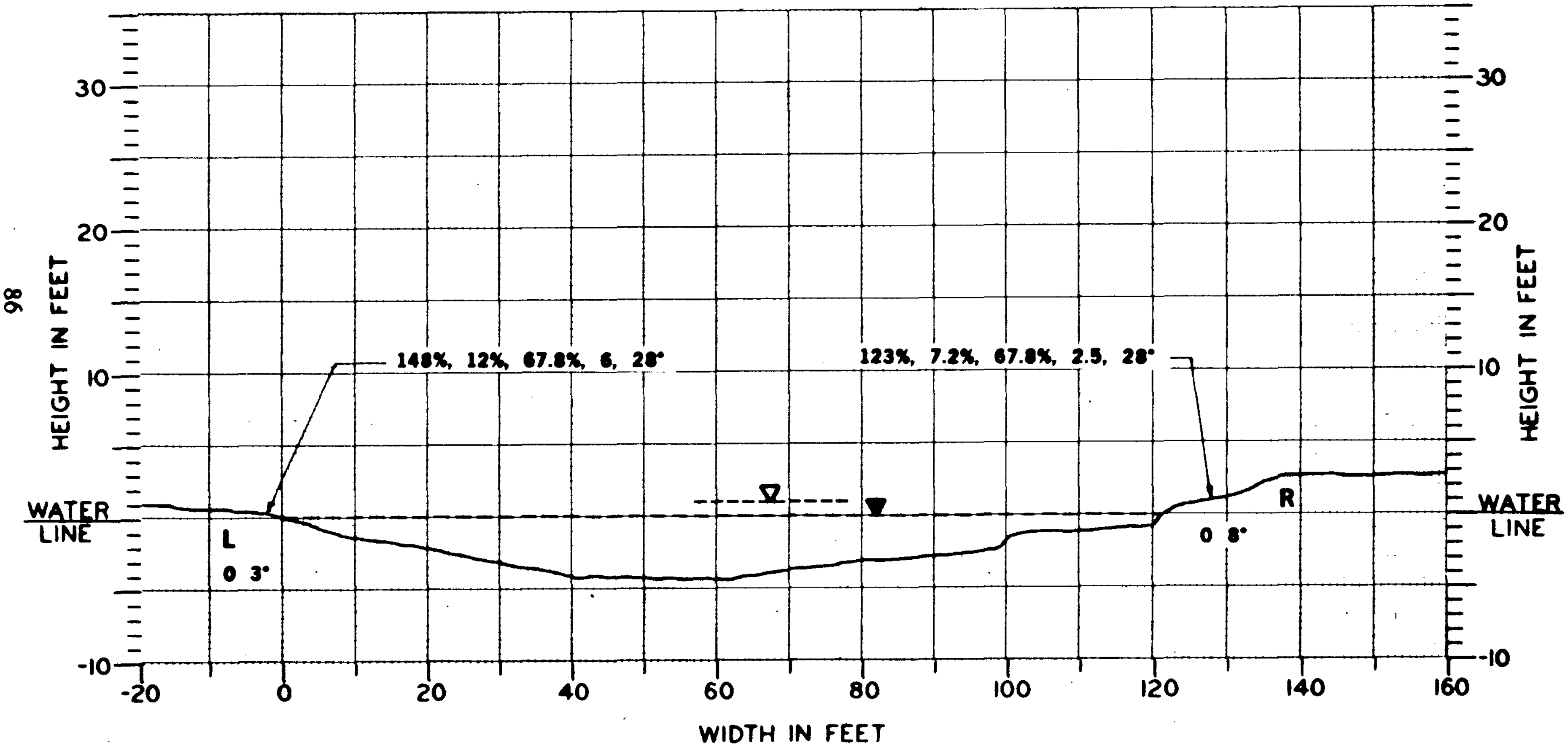
WIDTH OF STREAM (W-W) = 199.8 FT.
WIDTH OF BANKS (B-B) = 201.1 FT.
MEASURED DEPTH = 2.85 FT.



SITE NO. 21

HURON RIVER

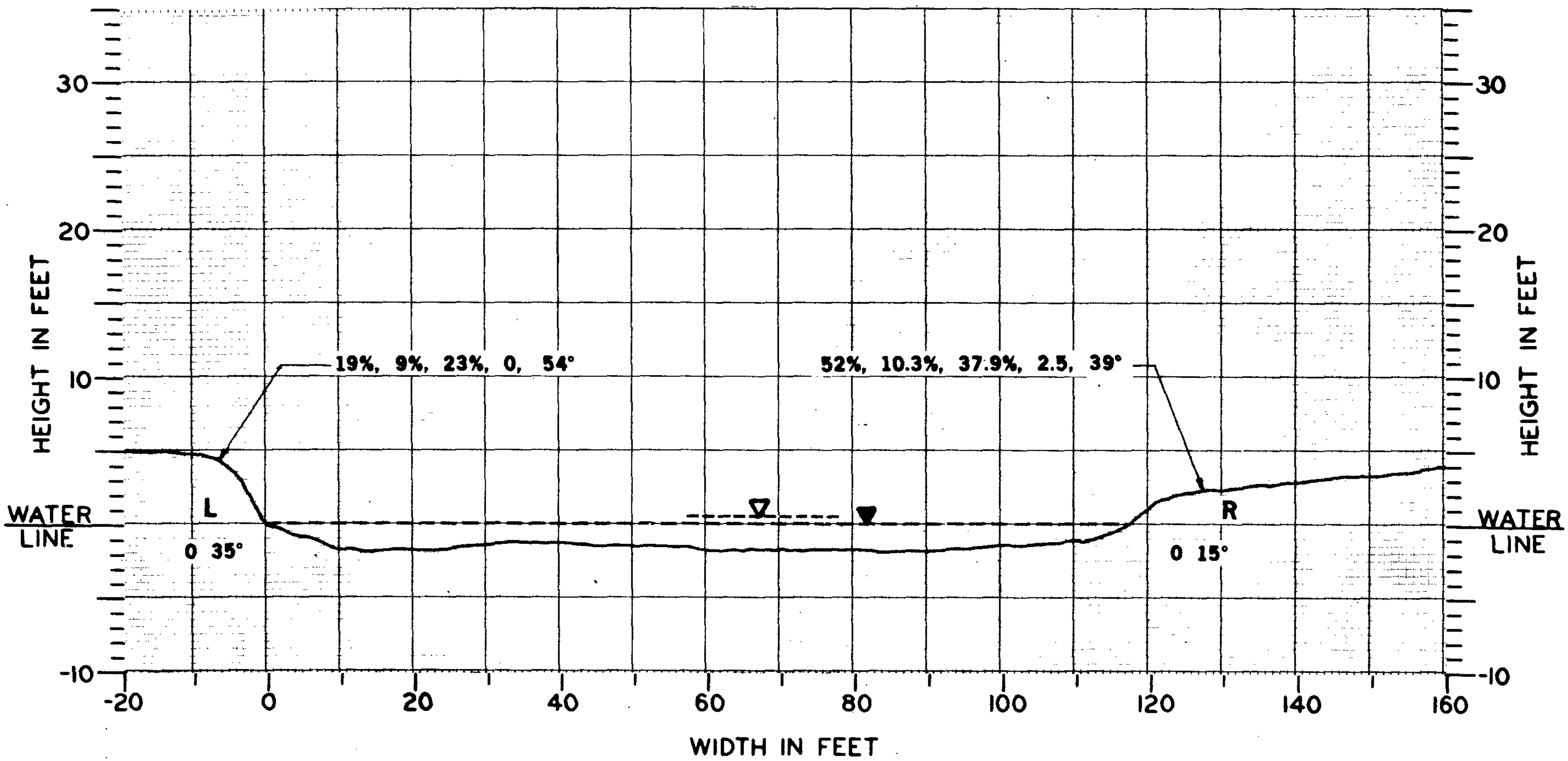
WIDTH OF STREAM (W-W) = 121 FT.
WIDTH OF BANKS (B-B) = 197 FT.
MEASURED DEPTH = 4.42 FT.



SITE NO. 22

HURON RIVER

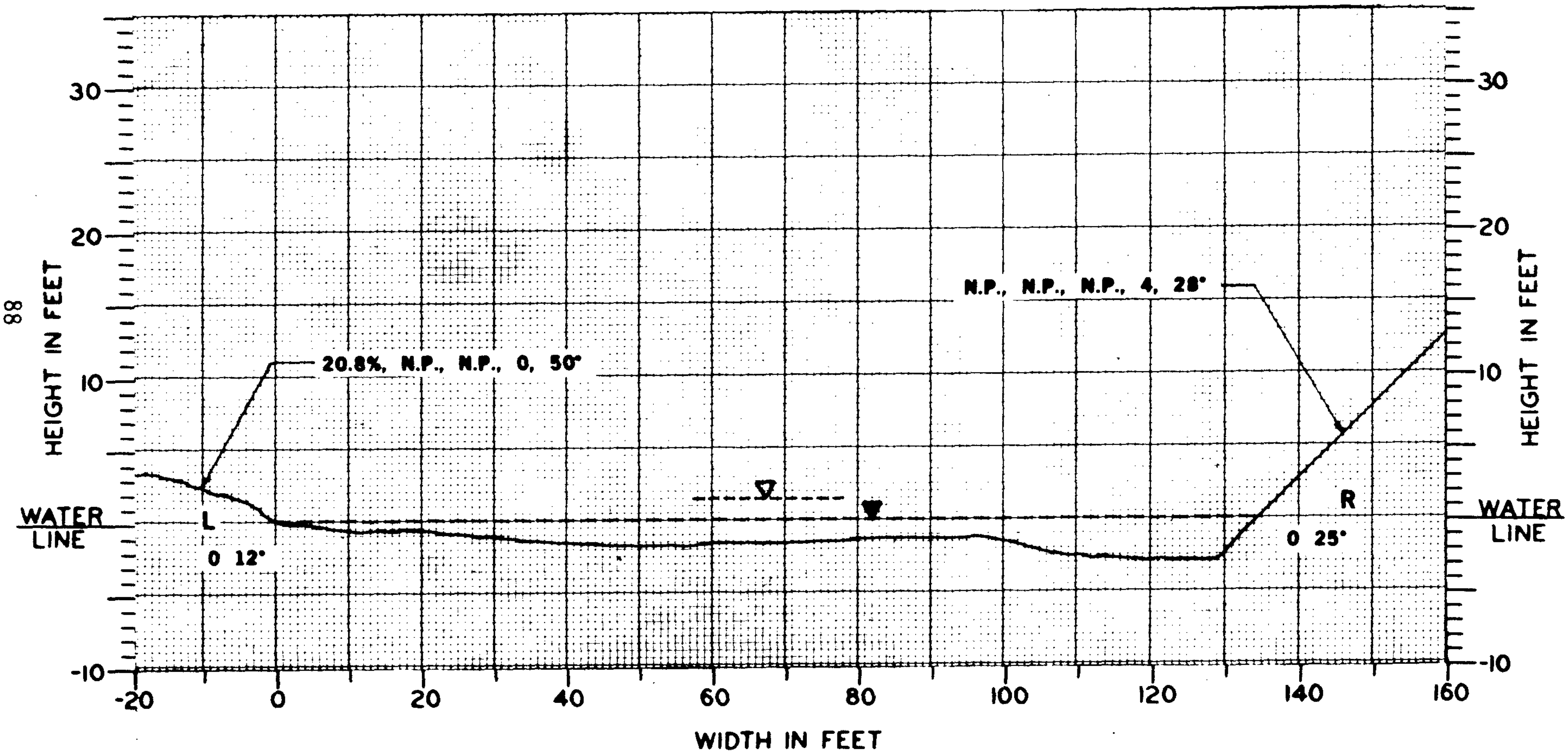
WIDTH OF STREAM (W-W) = 117.5 FT.
WIDTH OF BANKS (B-B) = 128.5 FT.
MEASURED DEPTH = 1.84 FT.



SITE NO. 23

HURON RIVER

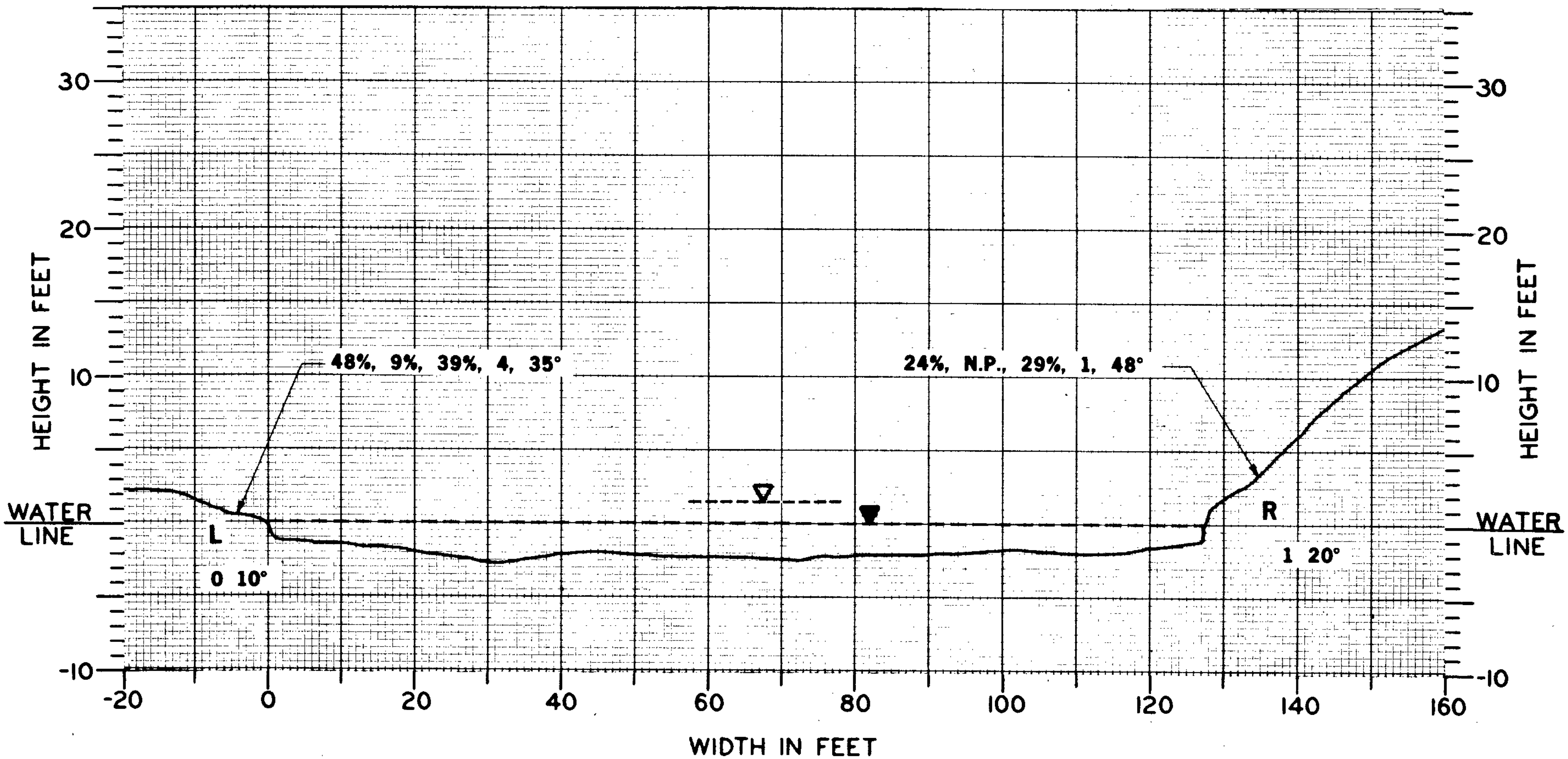
WIDTH OF STREAM (W-W) = 134.7 FT.
WIDTH OF BANKS (B-B) = 178.8 FT.
MEASURED DEPTH = 2.70 FT.



SITE NO. 24

HURON RIVER

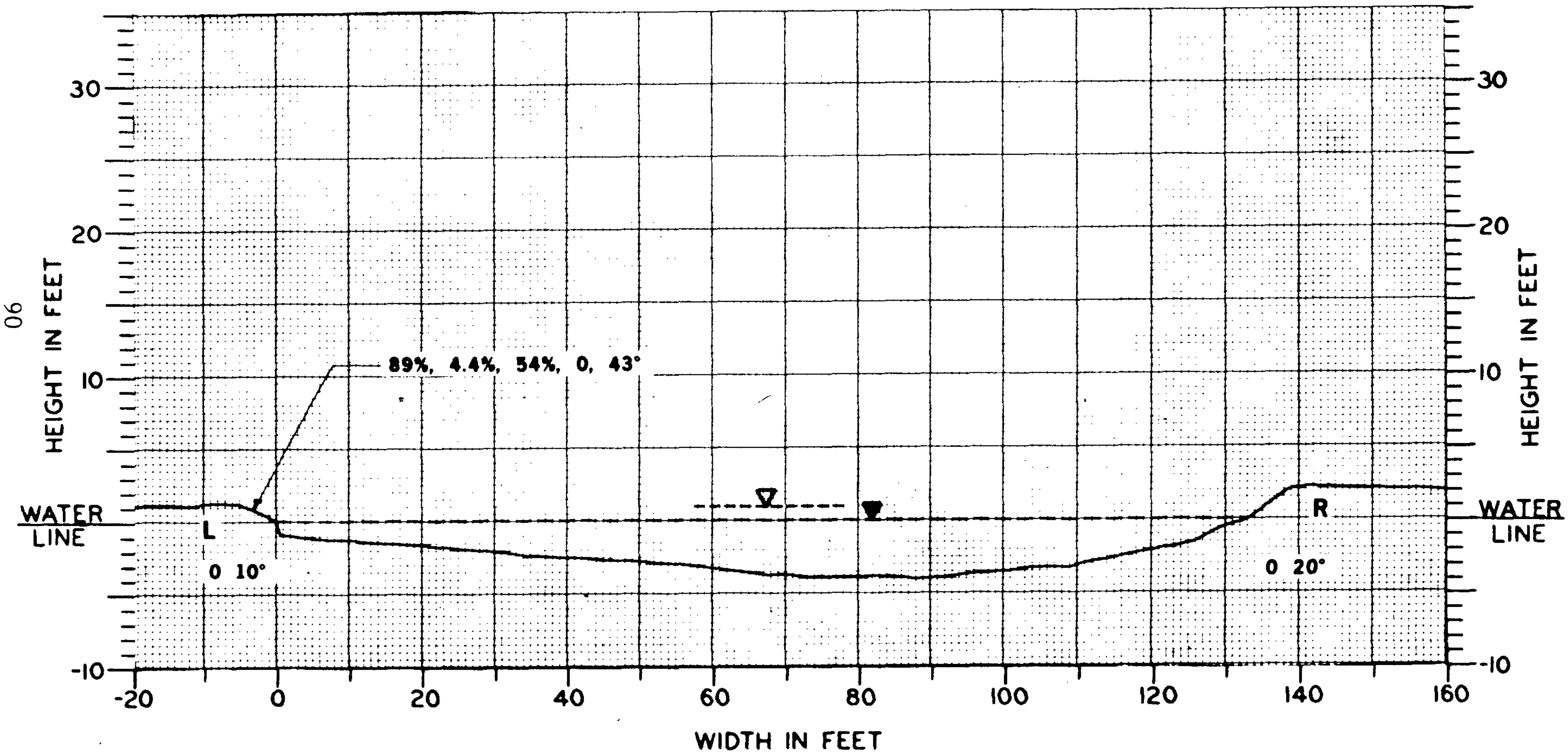
WIDTH OF STREAM (W-W) = 127.5 FT.
WIDTH OF BANKS (B-B) = 141.7 FT.
MEASURED DEPTH = 2.75 FT.



SITE NO. 25

HURON RIVER

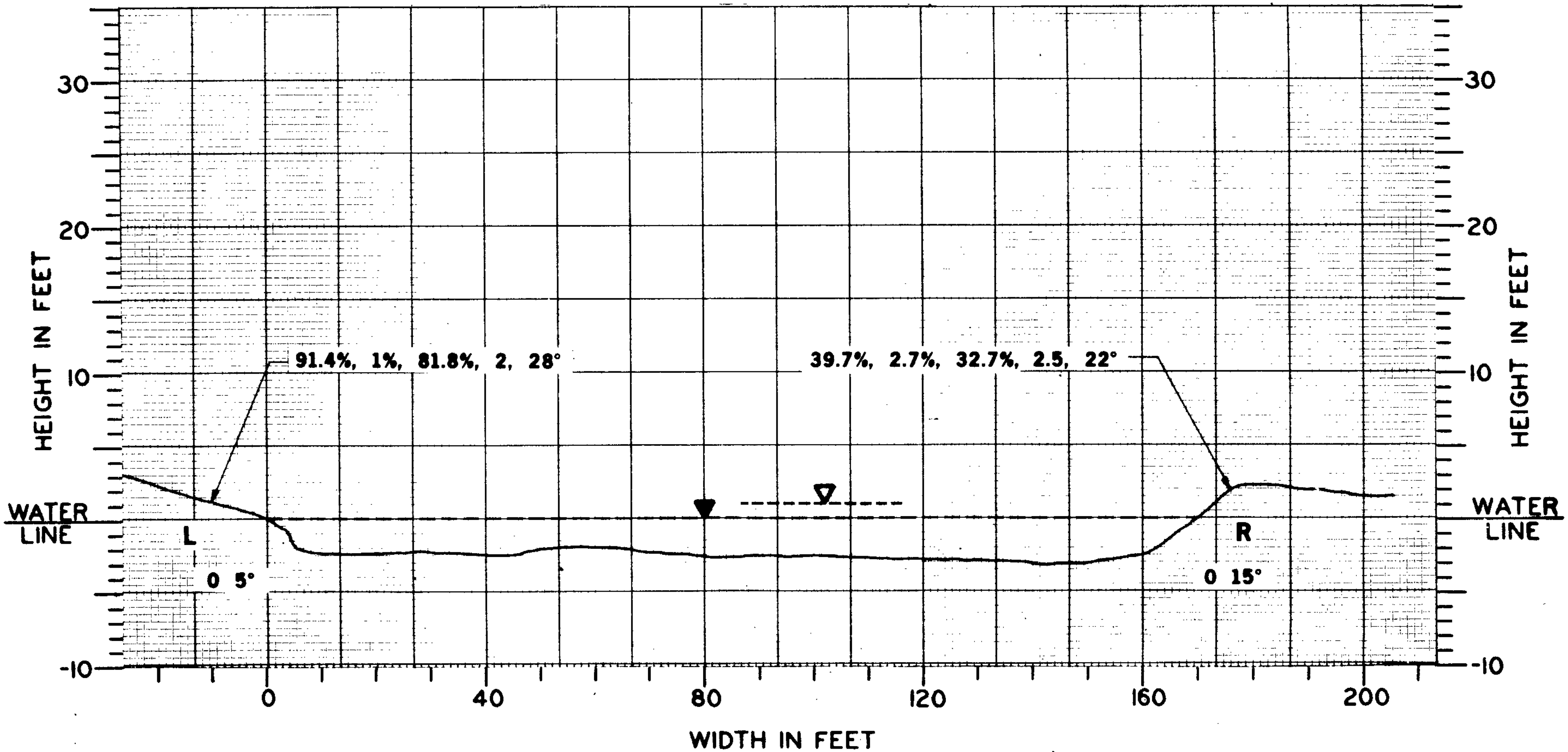
WIDTH OF STREAM (W-W) = 133 FT.
WIDTH OF BANKS (B-B) = 144 FT.
MEASURED DEPTH = 3.89 FT.



SITE NO. 26

HURON RIVER

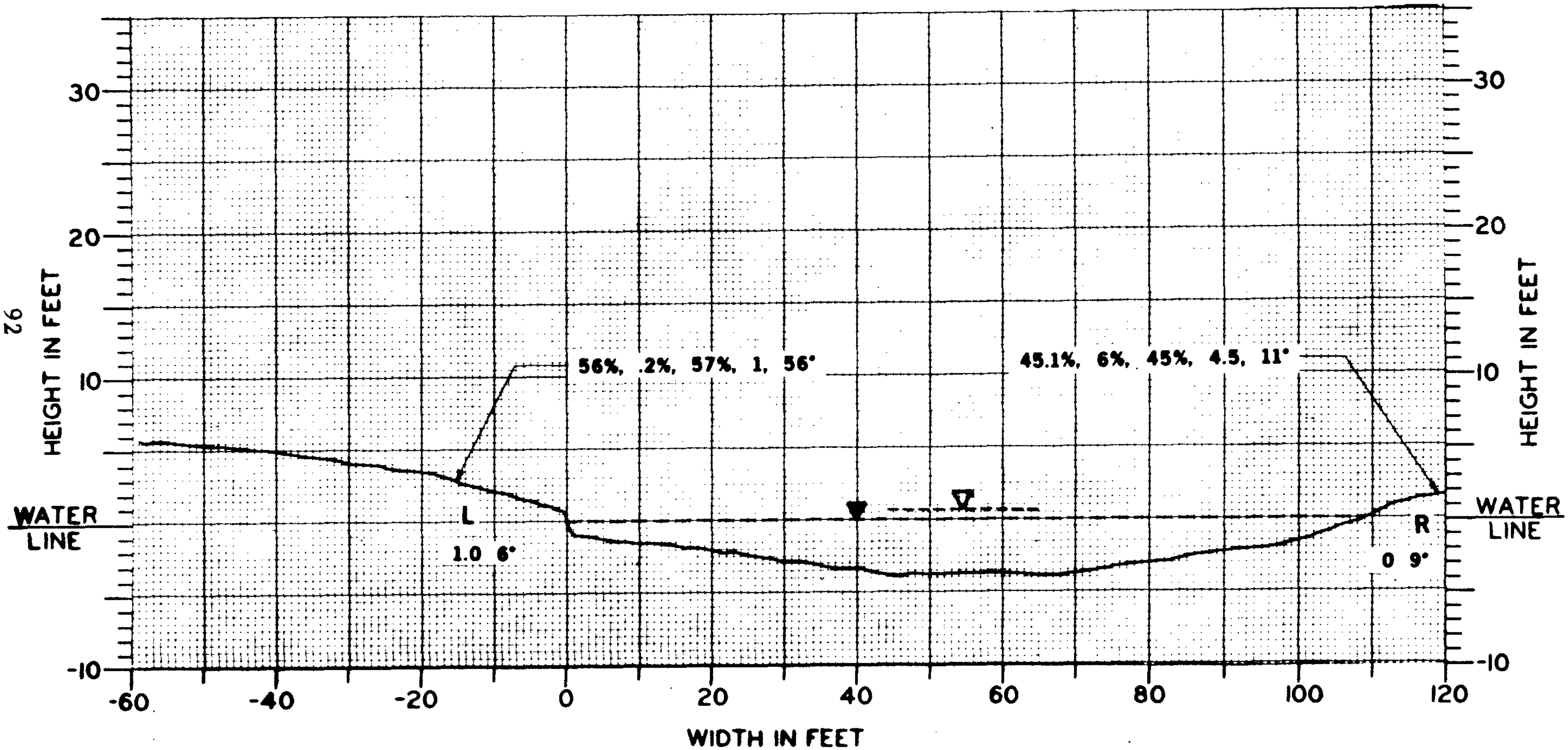
WIDTH OF STREAM (W-W) = 170 FT.
WIDTH OF BANKS (B-B) = 225.5 FT.
MEASURED DEPTH = 3.03 FT.



SITE NO. 27

HURON RIVER

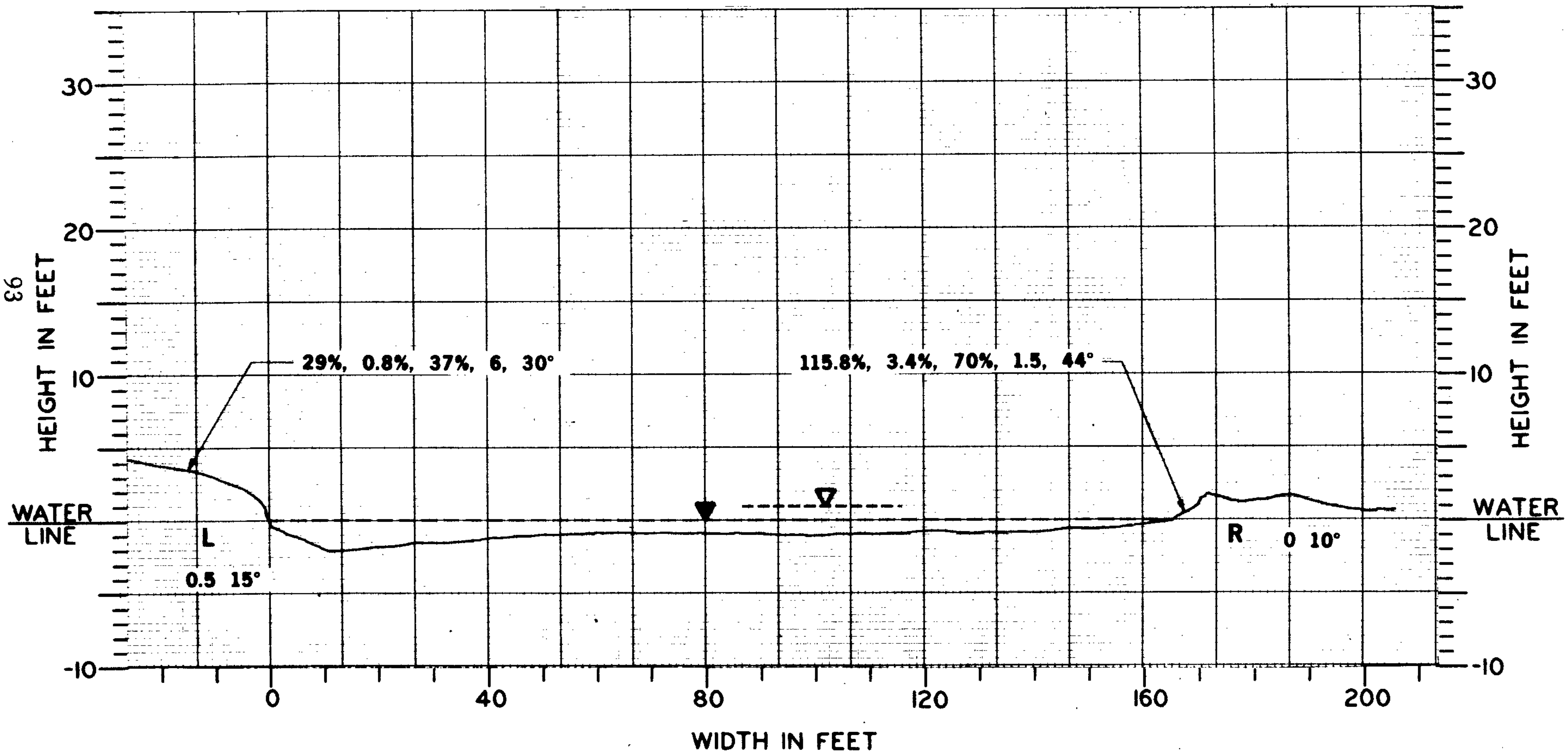
WIDTH OF STREAM (W-W) = 108.8 FT.
WIDTH OF BANKS (B-B) = 112.8 FT.
MEASURED DEPTH = 3.74 FT.



SITE NO. 28

HURON RIVER

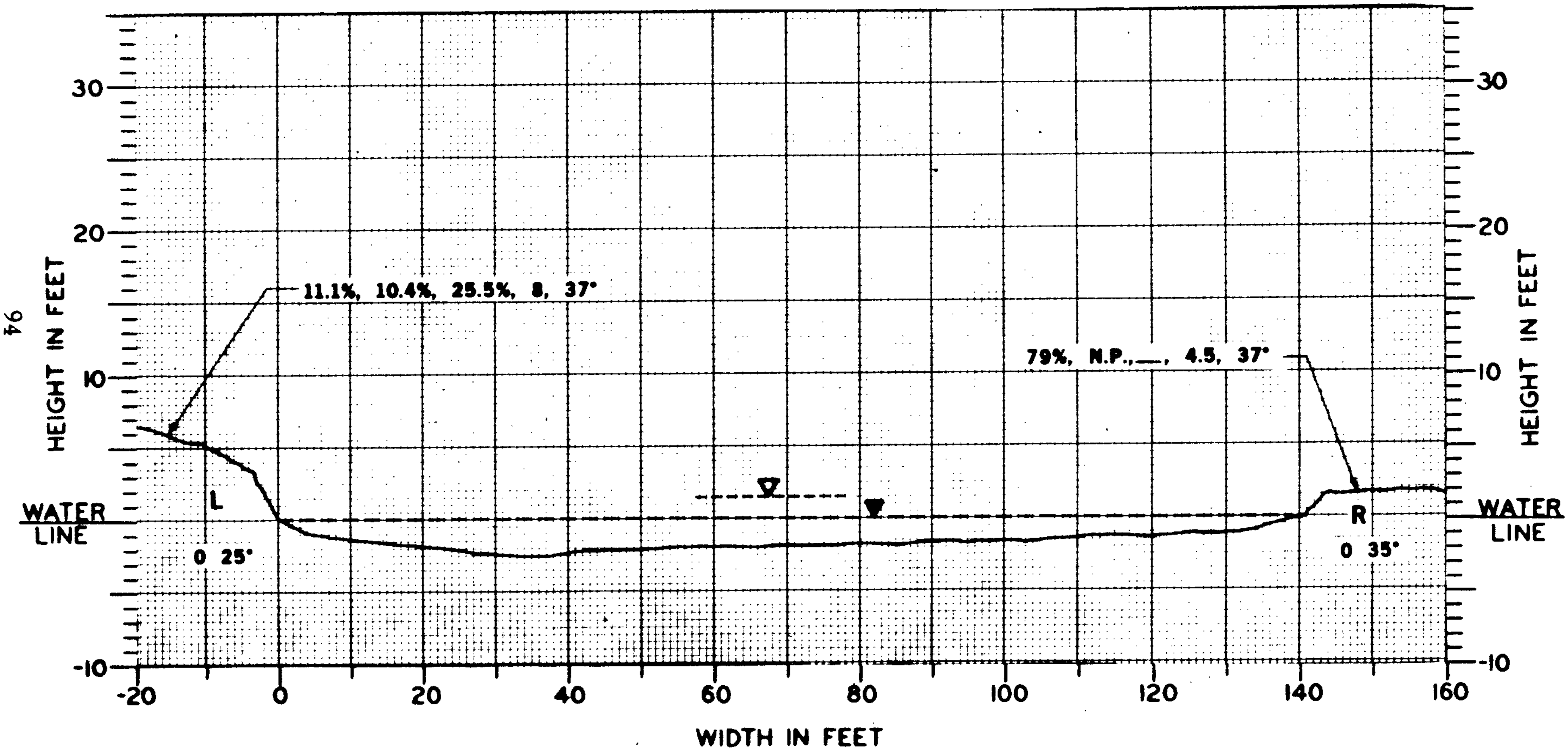
WIDTH OF STREAM (W-W) = 165.5 FT.
WIDTH OF BANKS (B-B) = 172.5 FT.
MEASURED DEPTH = 2.14 FT.



SITE NO. 29

HURON RIVER

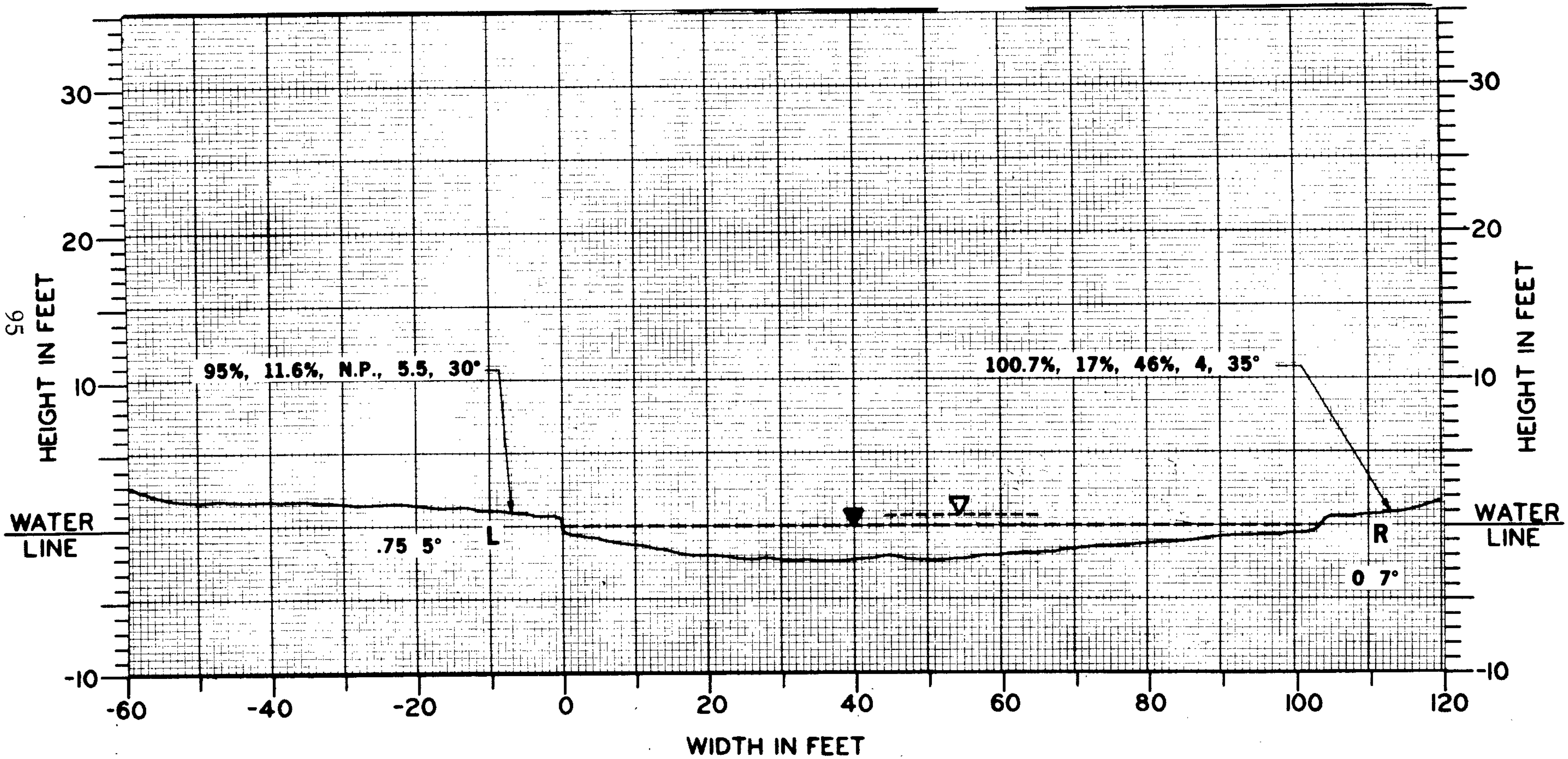
WIDTH OF STREAM (W-W) = 141 FT.
WIDTH OF BANKS (B-B) = 146.6 FT.
MEASURED DEPTH = 2.55 FT.



SITE NO. 30

HURON RIVER

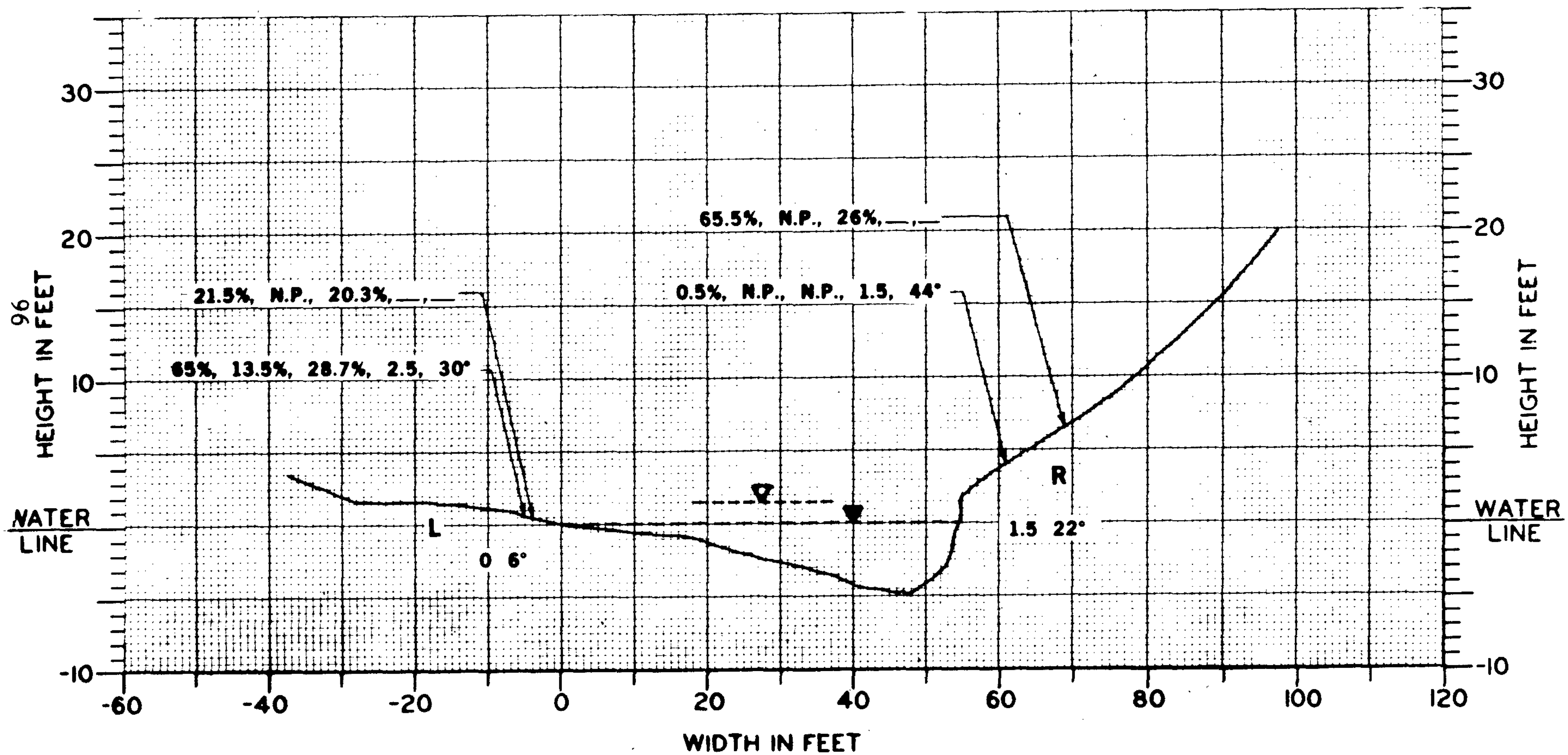
WIDTH OF STREAM (W-W) = 103.2 FT.
WIDTH OF BANKS (B-B) = 104.2 FT.
MEASURED DEPTH = 2.42 FT.



SITE NO. 31

HURON RIVER

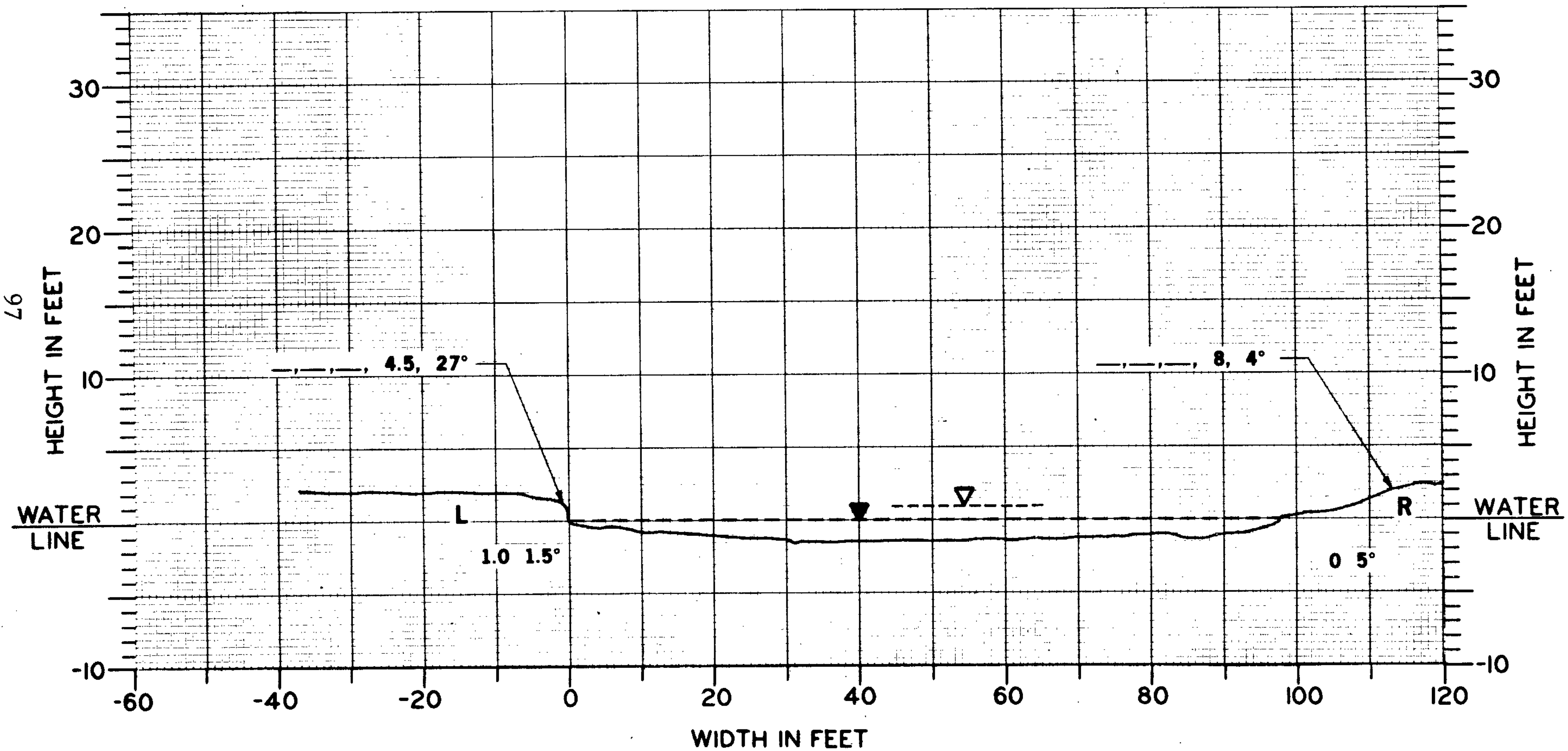
WIDTH OF STREAM (W-W) = 54.4 FT.
WIDTH OF BANKS (B-B) = 108.6 FT.
MEASURED DEPTH = 4.98 FT.



SITE NO. 32

HURON RIVER

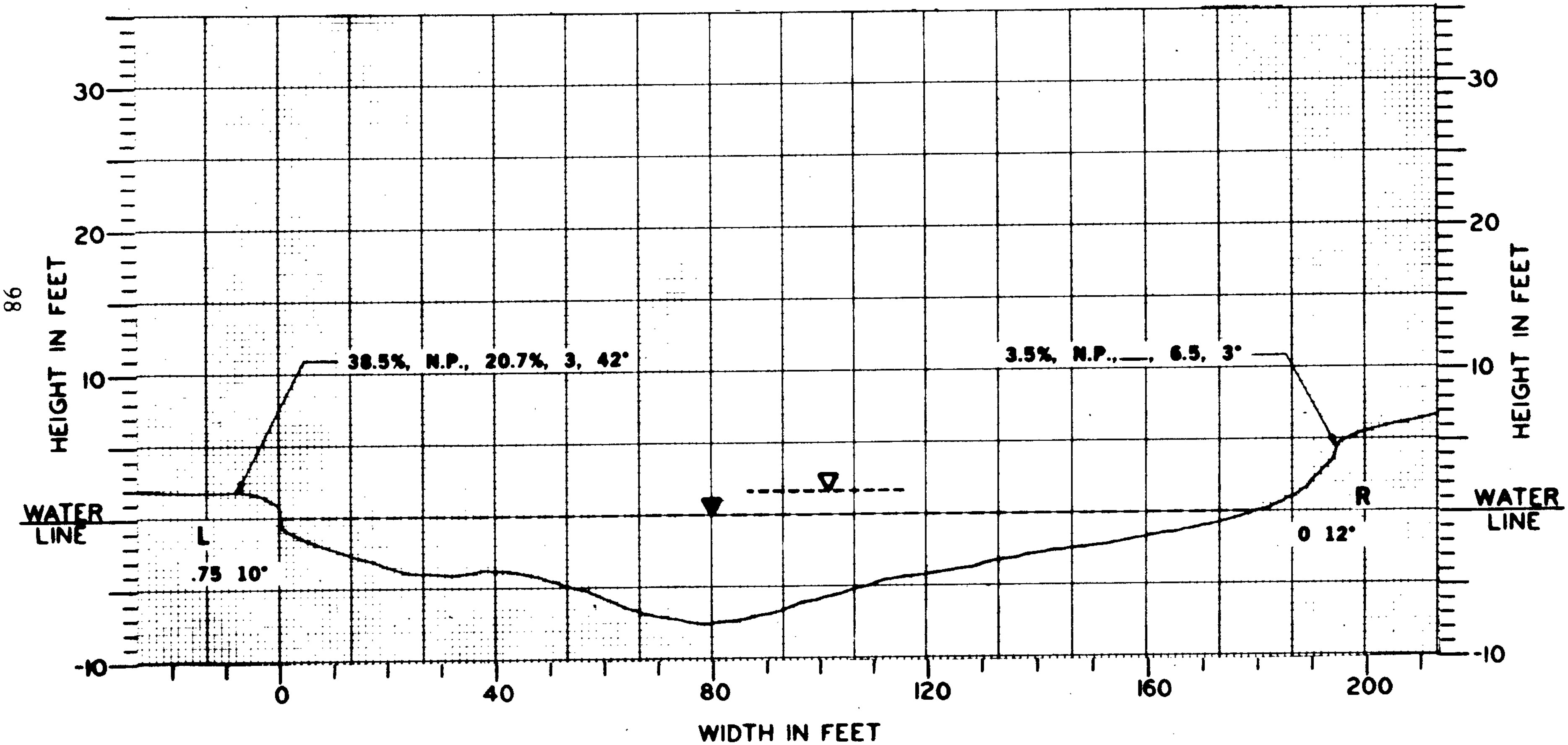
WIDTH OF STREAM (W-W) = 97.5 FT.
WIDTH OF BANKS (B-B) = 114.5 FT.
MEASURED DEPTH = 1.44 FT.



SITE NO. 33

HURON RIVER

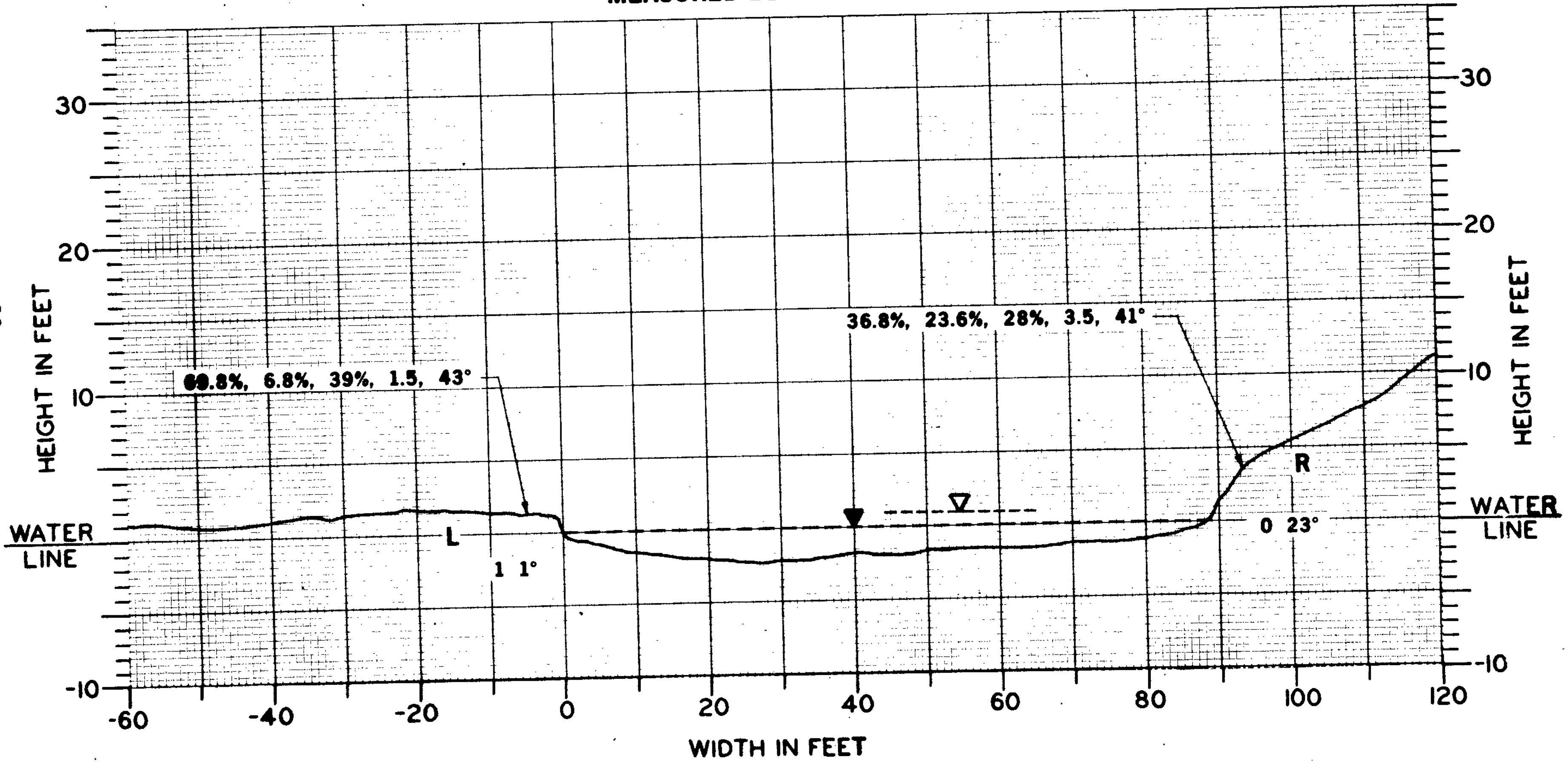
WIDTH OF STREAM (W-W) = 179.5 FT.
WIDTH OF BANKS (B-B) = 194.2 FT.
MEASURED DEPTH = 7.60 FT.



SITE NO. 34

HURON RIVER

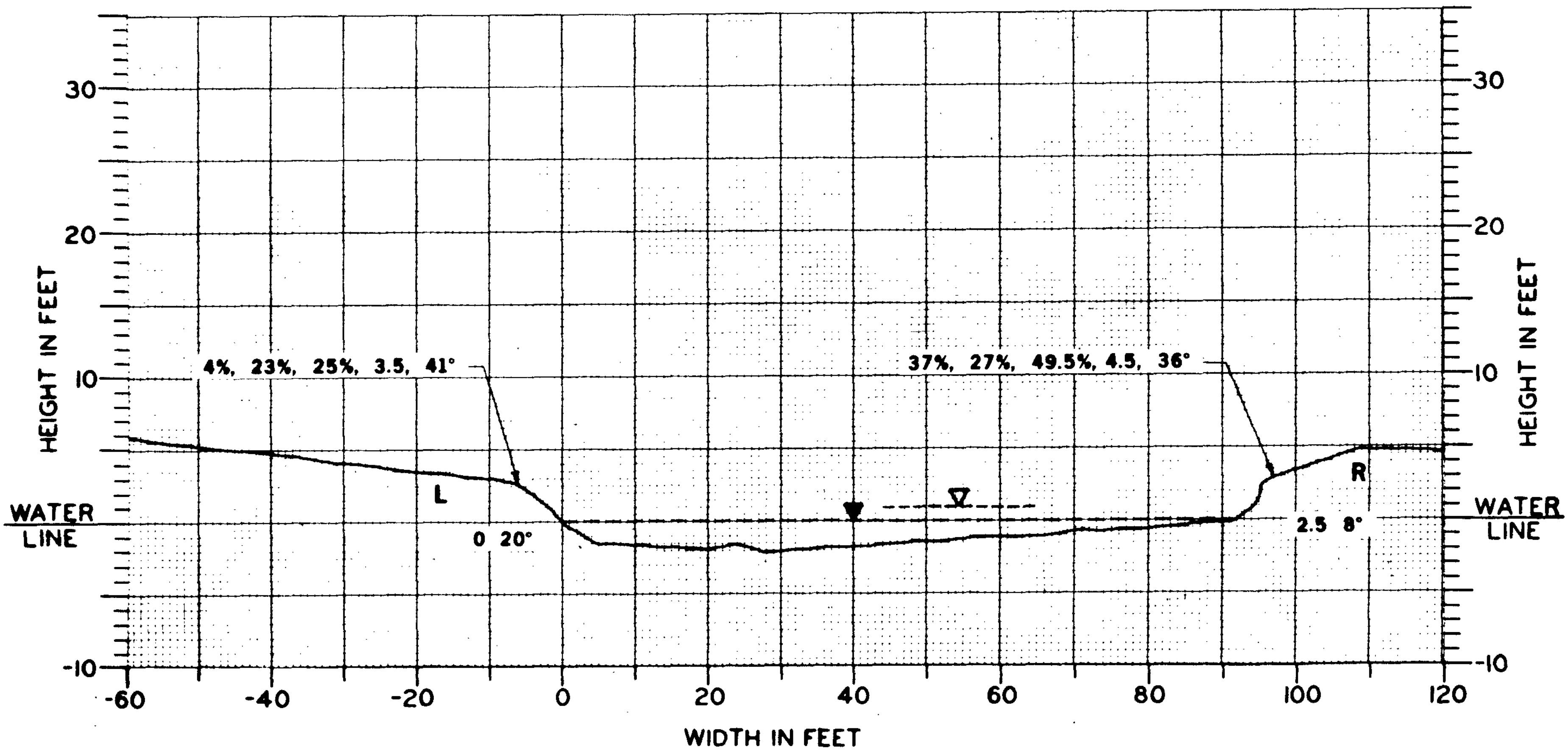
WIDTH OF STREAM (W-W) = 88.3 FT.
WIDTH OF BANKS (B-B) = 140.3 FT.
MEASURED DEPTH = 2.23 FT.



SITE NO. 35

HURON RIVER

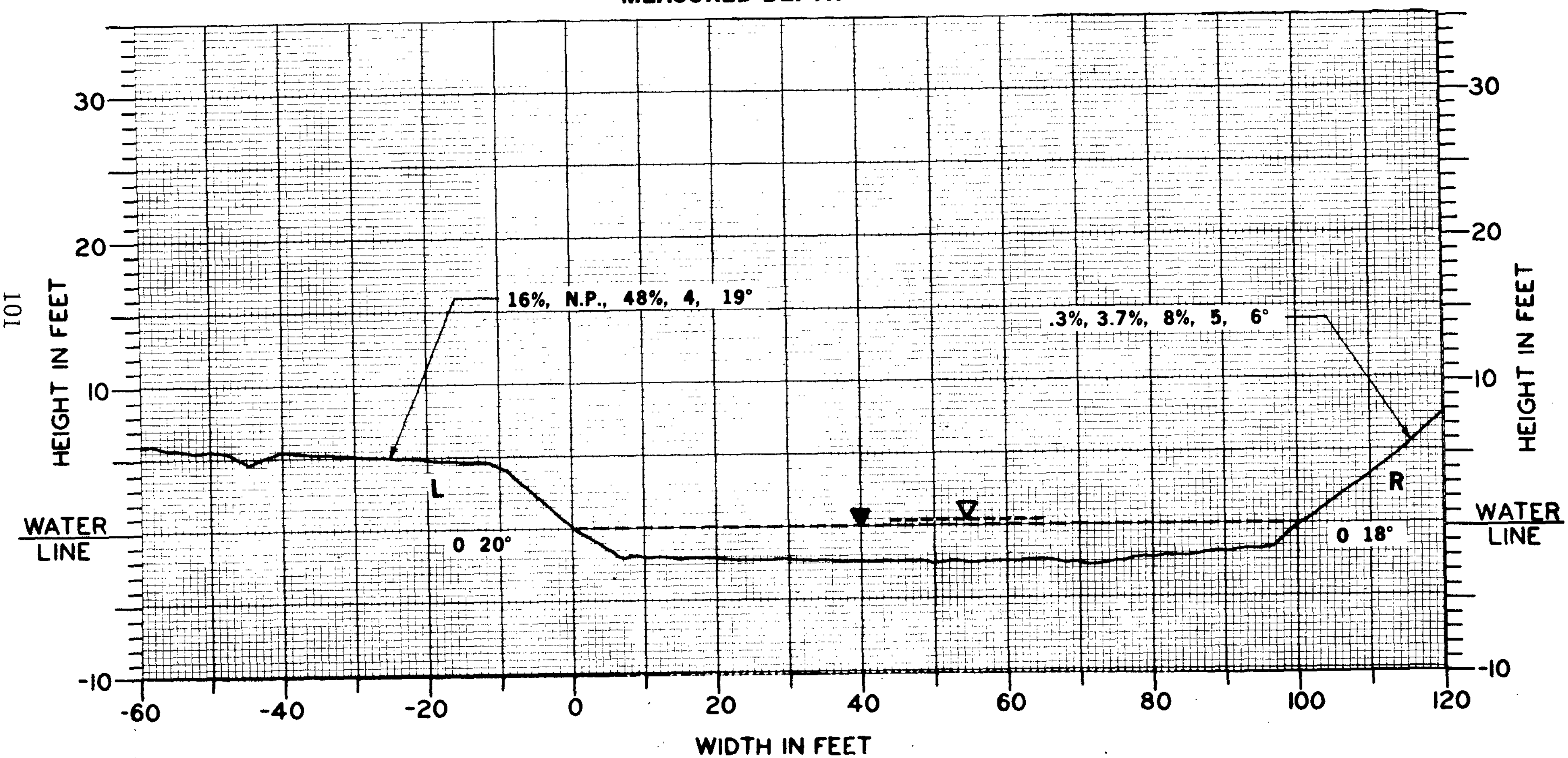
WIDTH OF STREAM (W-W) = 92.0 FT.
WIDTH OF BANKS (B-B) = 103.4 FT.
MEASURED DEPTH = 2.0 FT.



SITE NO. 36

HURON RIVER

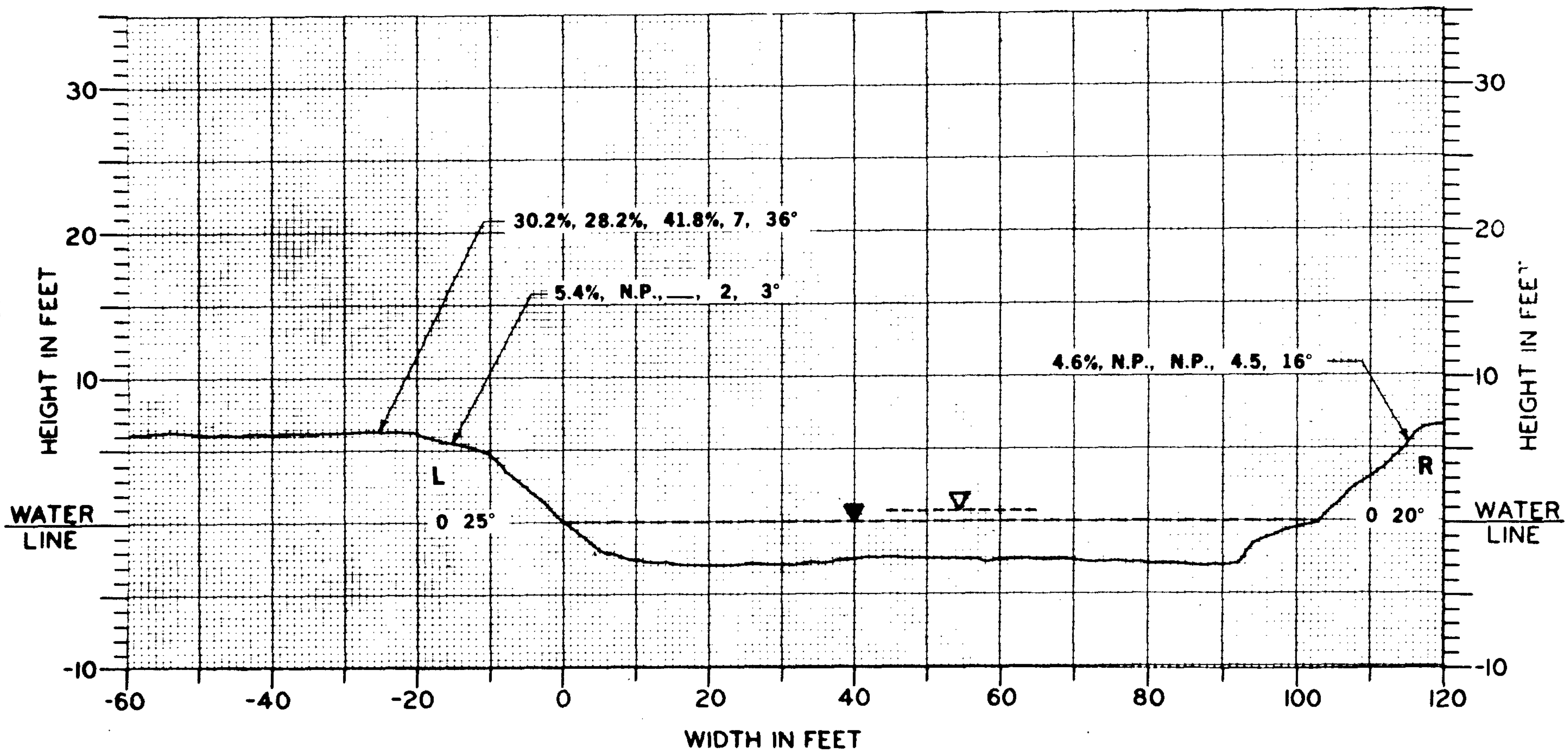
WIDTH OF STREAM (W-W) = 100.5 FT.
WIDTH OF BANKS (B-B) = 138.3 FT.
MEASURED DEPTH = 2.73 FT.



SITE NO. 37

HURON RIVER

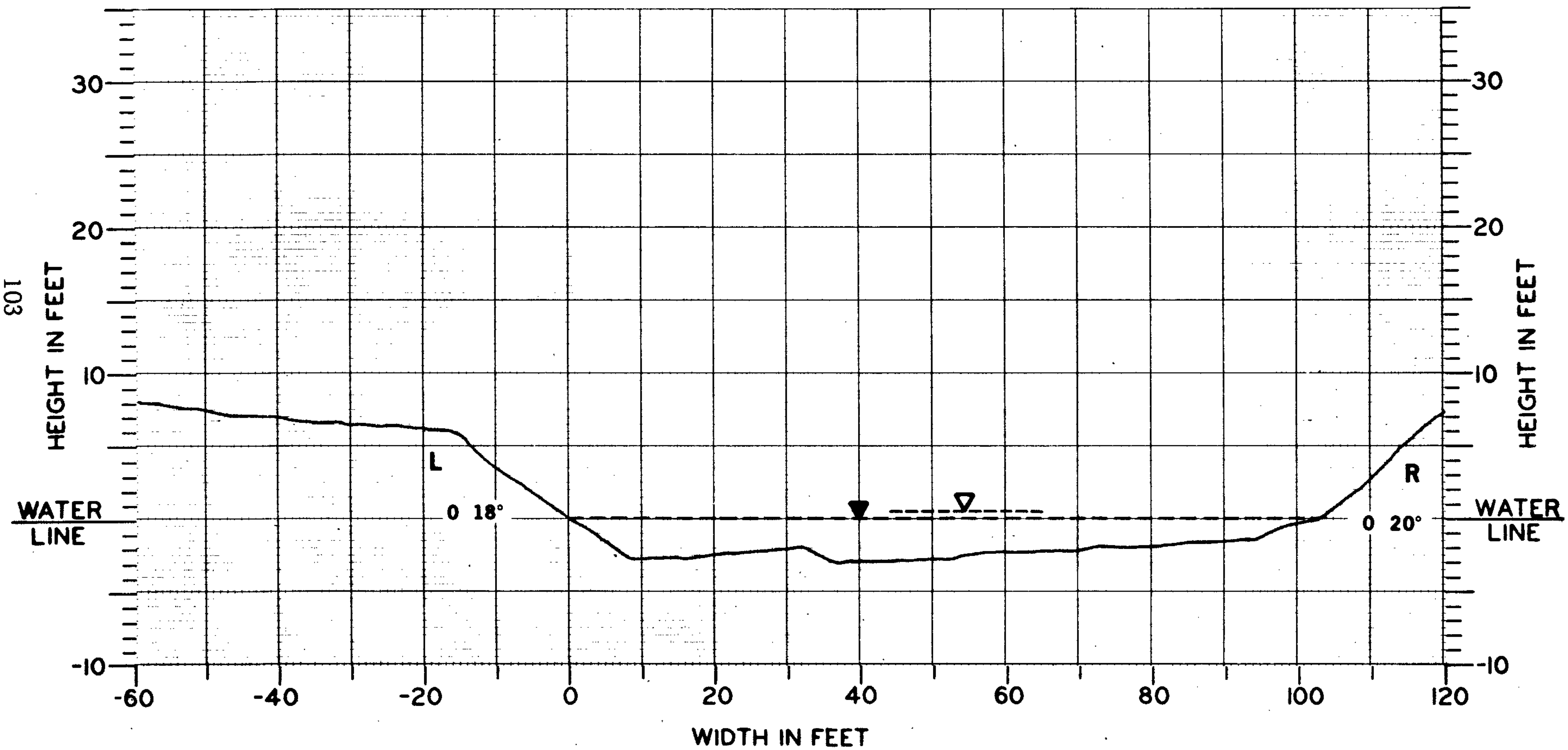
WIDTH OF STREAM (W-W) = 103 FT.
WIDTH OF BANKS (B-B) = 146.8 FT.
MEASURED DEPTH = 3.0 FT.



SITE NO. 38

HURON RIVER

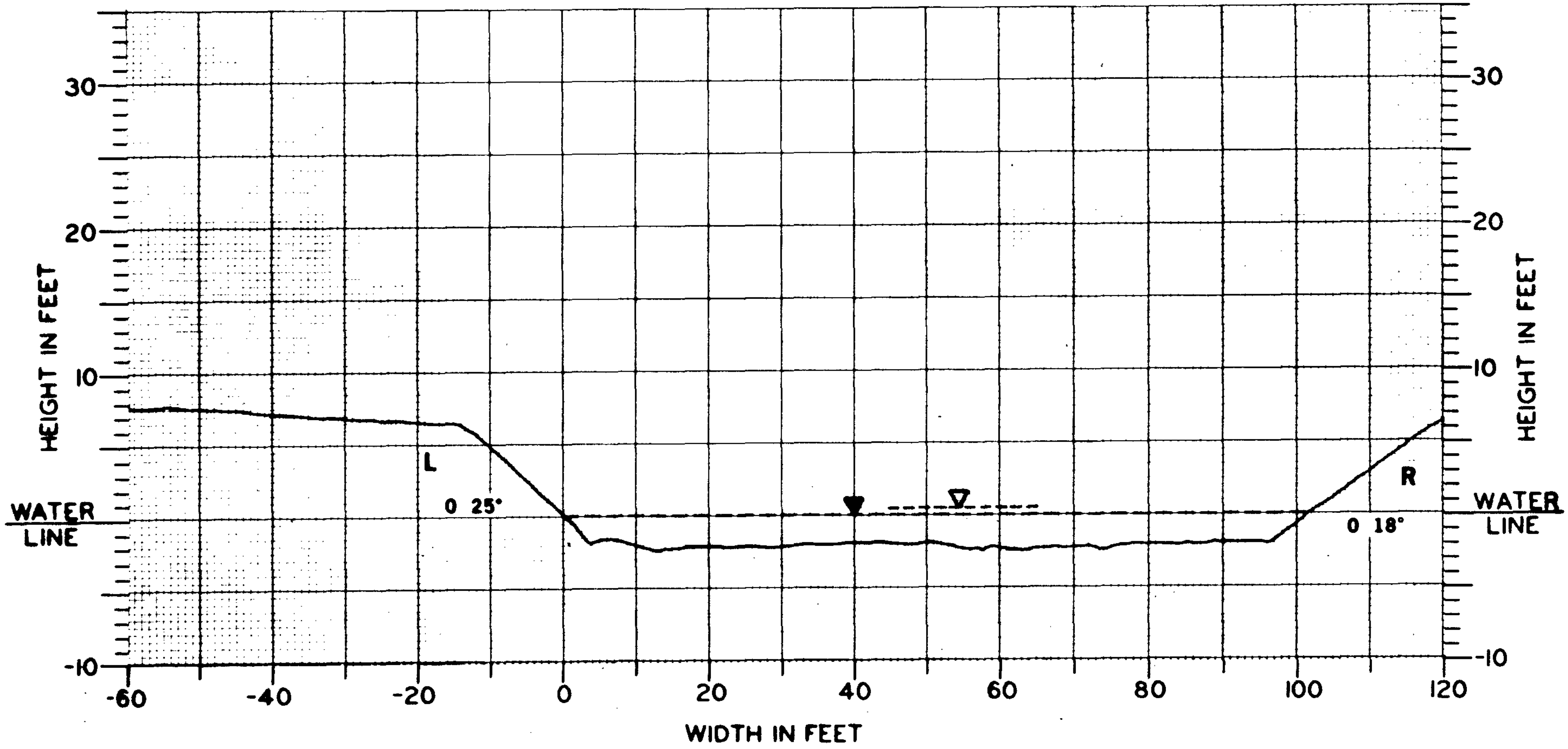
WIDTH OF STREAM (W-W) = 103.2 FT.
WIDTH OF BANKS (B-B) = 144 FT.
MEASURED DEPTH = 2.95 FT.



SITE NO. 39

HURON RIVER

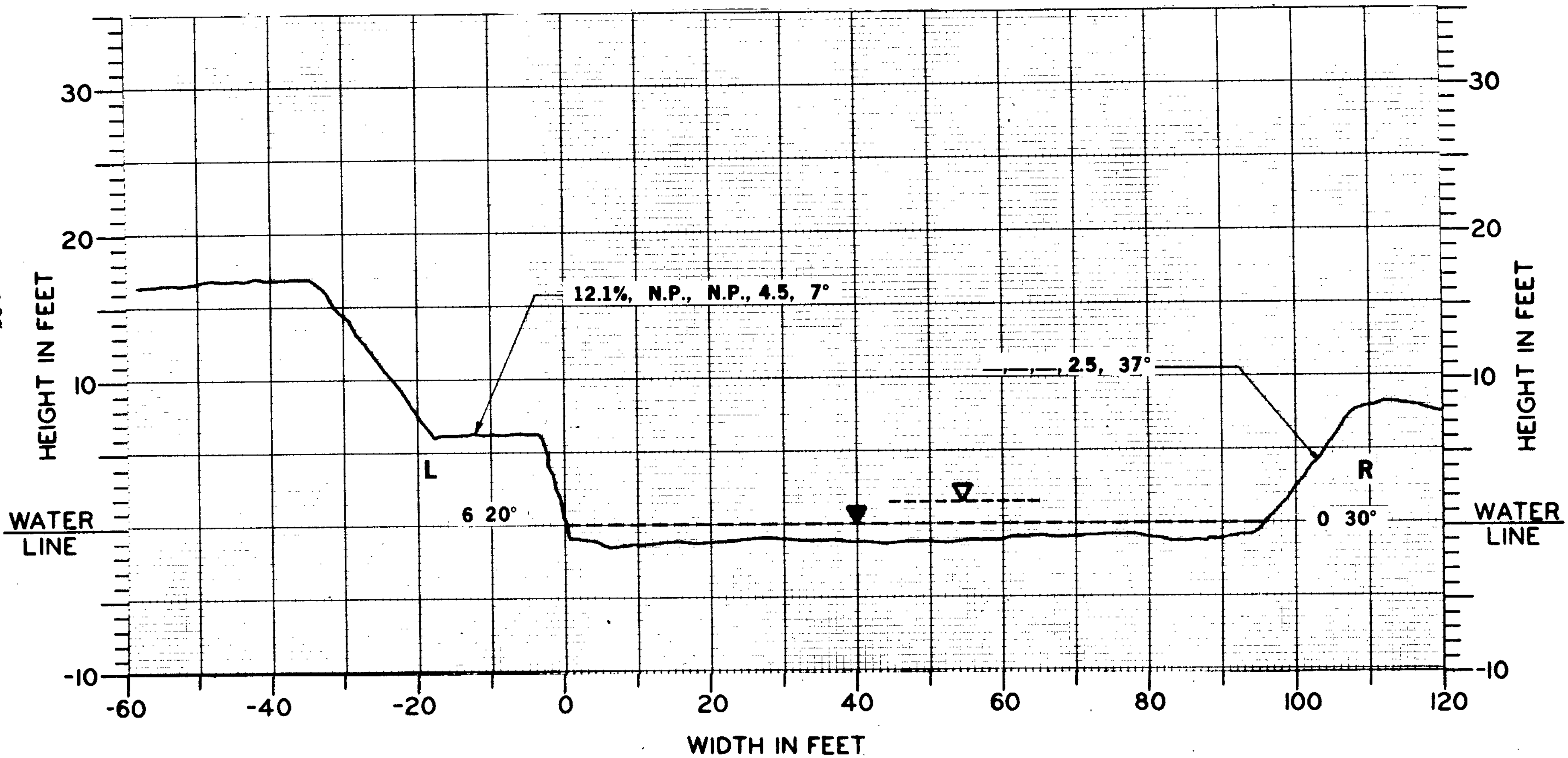
WIDTH OF STREAM (W-W) = 101.5 FT.
WIDTH OF BANKS (B-B) = 143 FT.
MEASURED DEPTH = 2.30 FT.



SITE NO. 40

HURON RIVER

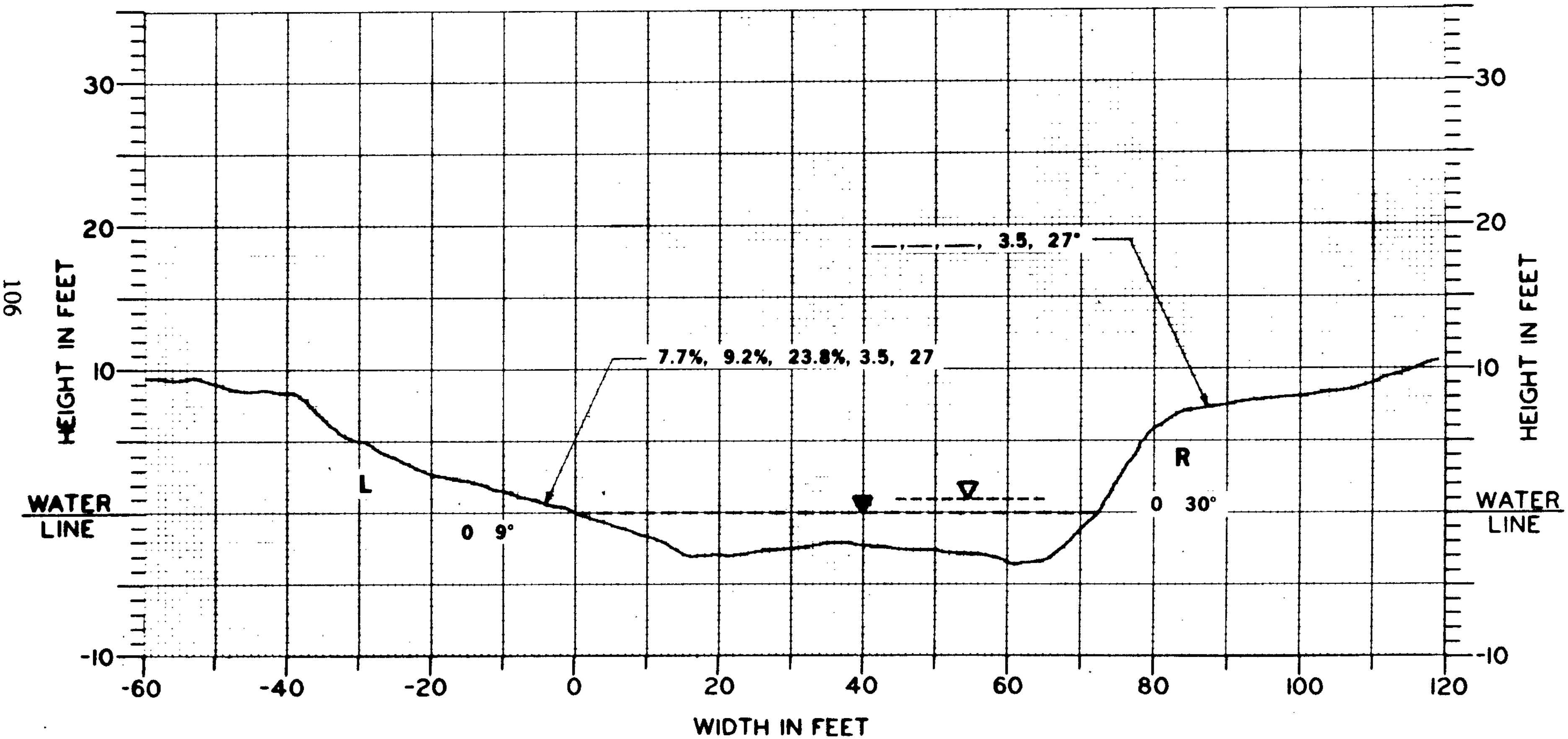
WIDTH OF STREAM (W-W) = 95.3 FT.
WIDTH OF BANKS (B-B) = 110.8 FT.
MEASURED DEPTH = 1.36 FT.



SITE NO. 41

HURON RIVER

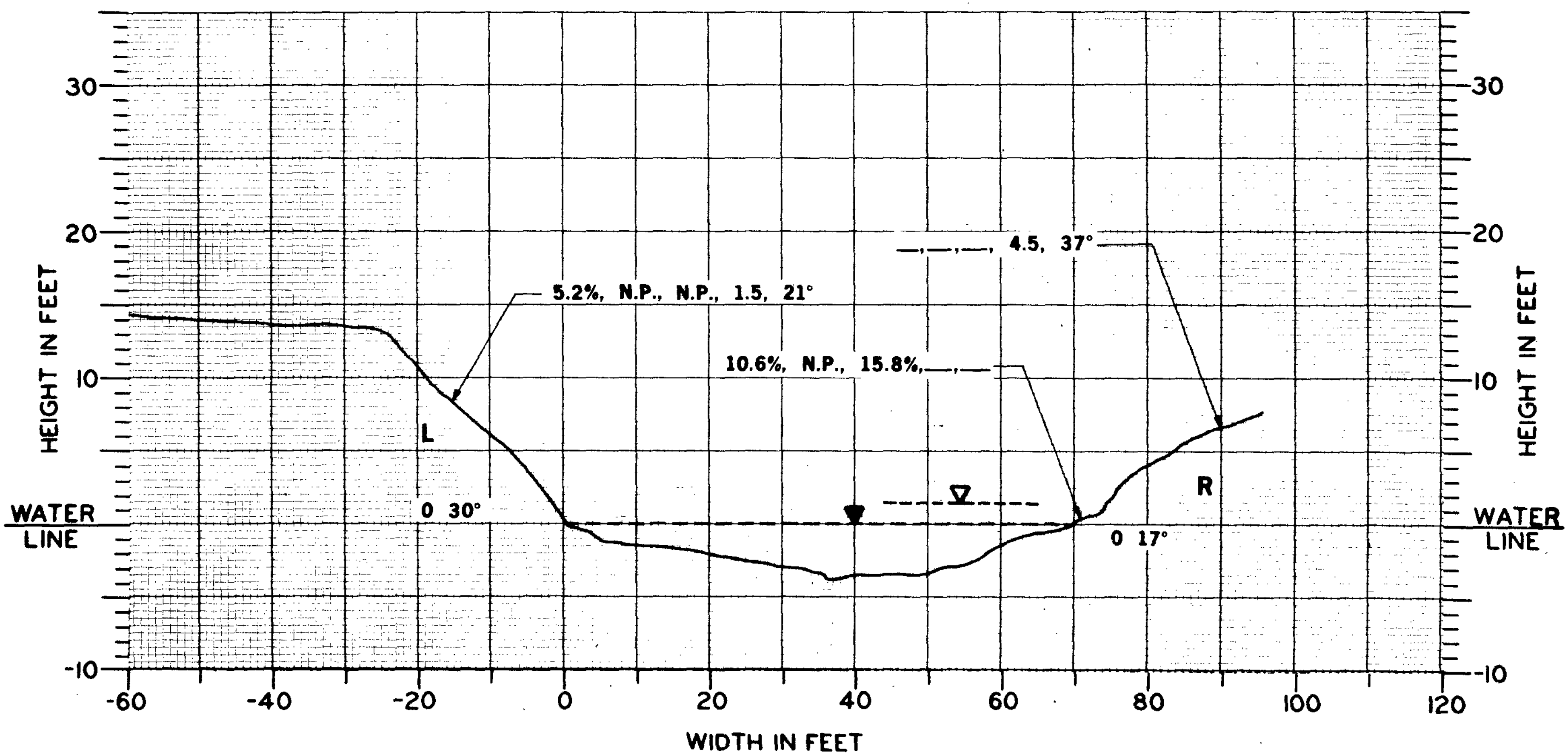
WIDTH OF STREAM (W-W) = 72.5 FT.
WIDTH OF BANKS (B-B) = 121.8 FT.
MEASURED DEPTH = 3.56 FT.



SITE NO. 42

HURON RIVER

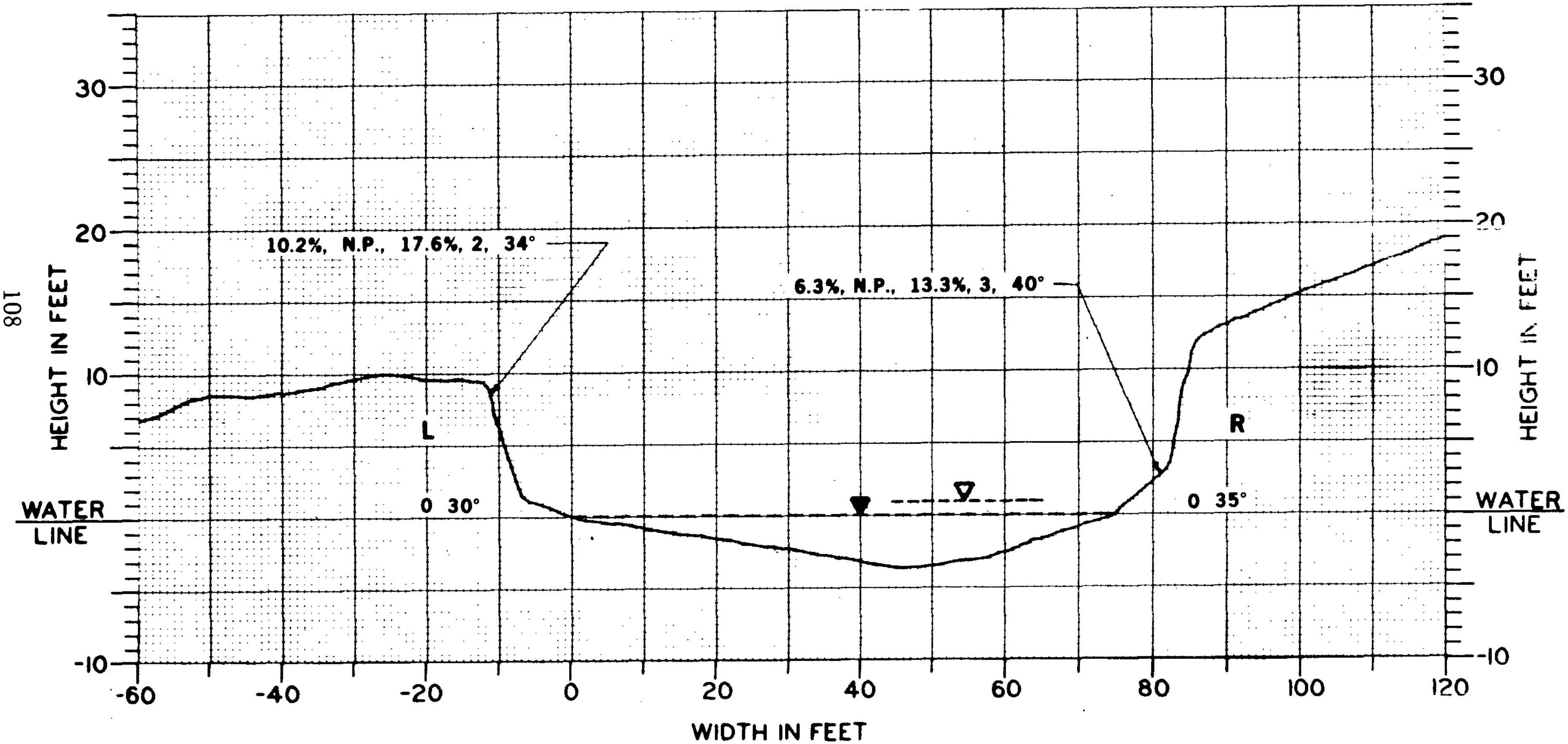
WIDTH OF STREAM (W-W) = 70.0 FT.
WIDTH OF BANKS (B-B) = 96.2 FT.
MEASURED DEPTH = 3.9 FT.



SITE NO. 43

HURON RIVER

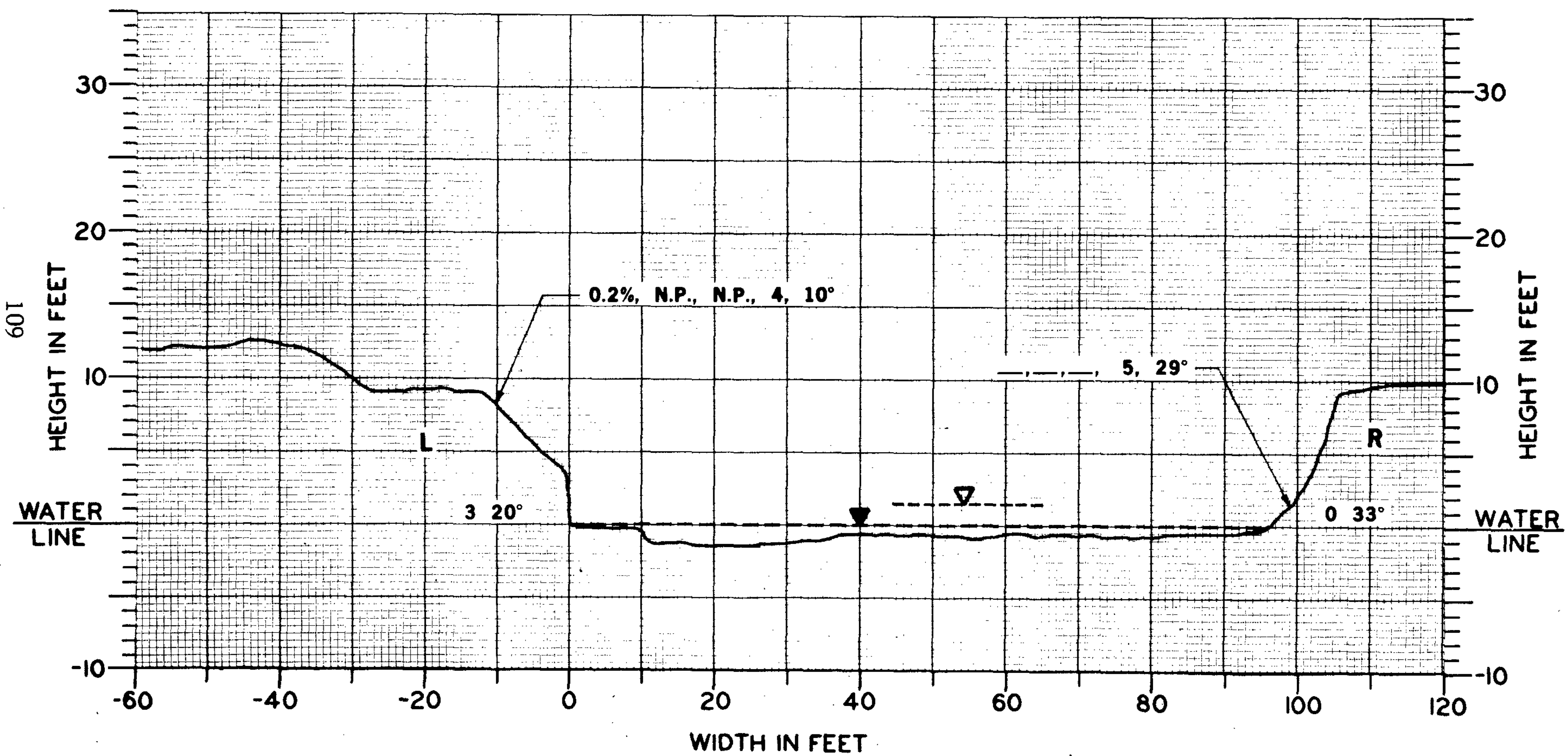
WIDTH OF STREAM (W-W) = 75.0 FT.
WIDTH OF BANKS (B-B) = 97.1 FT.
MEASURED DEPTH = 3.6 FT.



SITE NO. 44

HURON RIVER

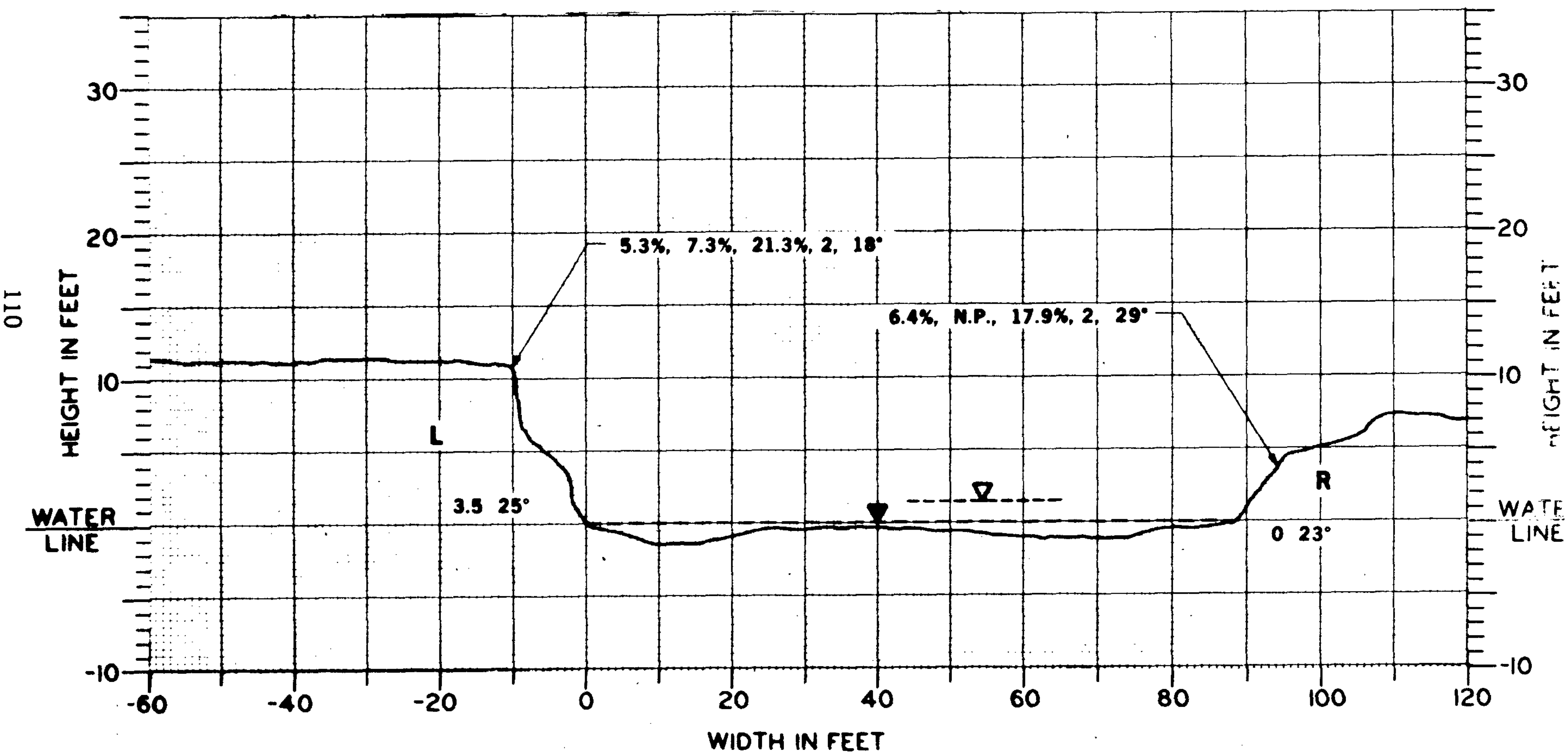
WIDTH OF STREAM (W-W) = 96.0 FT.
WIDTH OF BANKS (B-B) = 105.4 FT.
MEASURED DEPTH = 1.53 FT.



SITE NO. 45

HURON RIVER

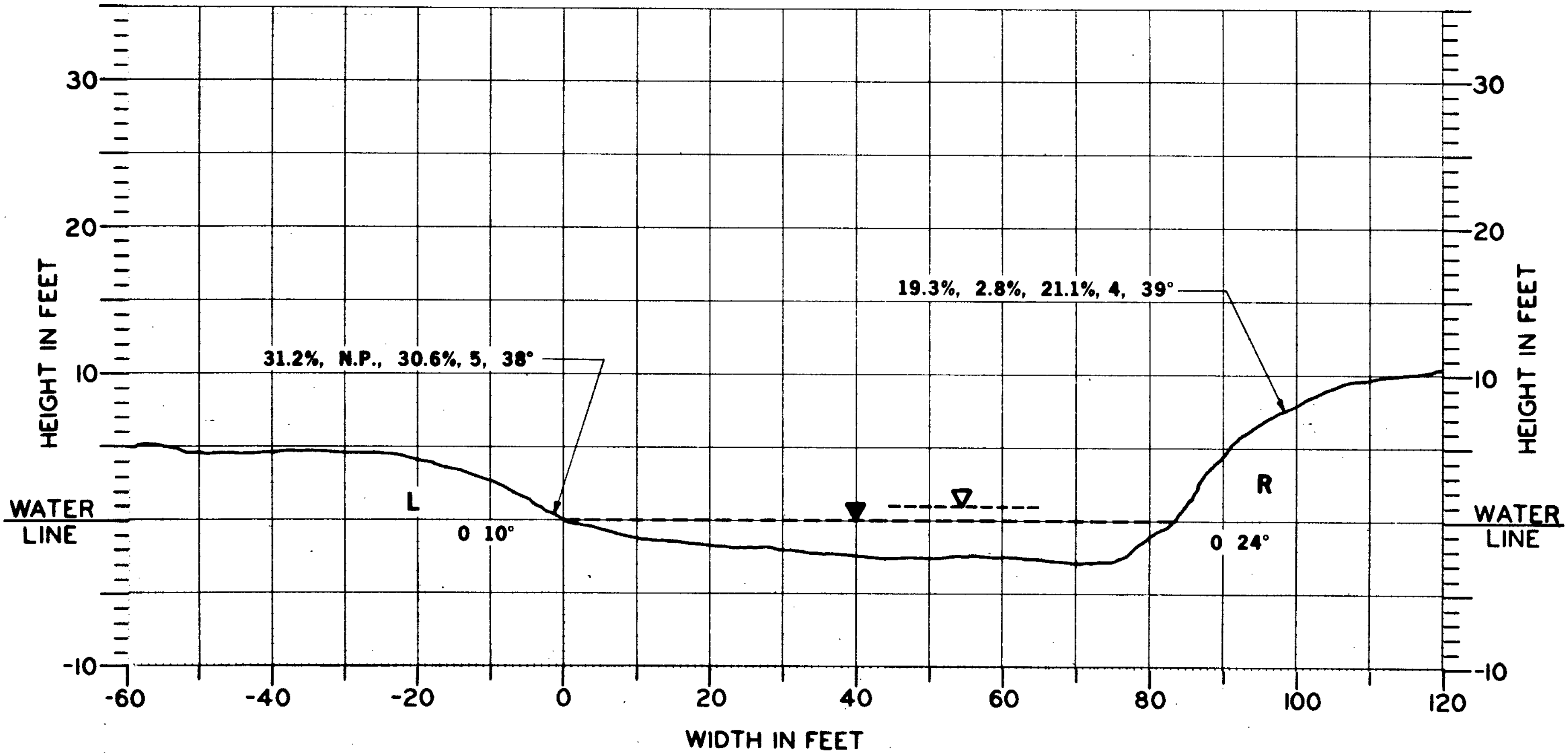
WIDTH OF STREAM (W-W) = 88.7 FT.
WIDTH OF BANKS (B-B) = 106.0 FT.
MEASURED DEPTH = 1.52 FT.



SITE NO. 46

HURON RIVER

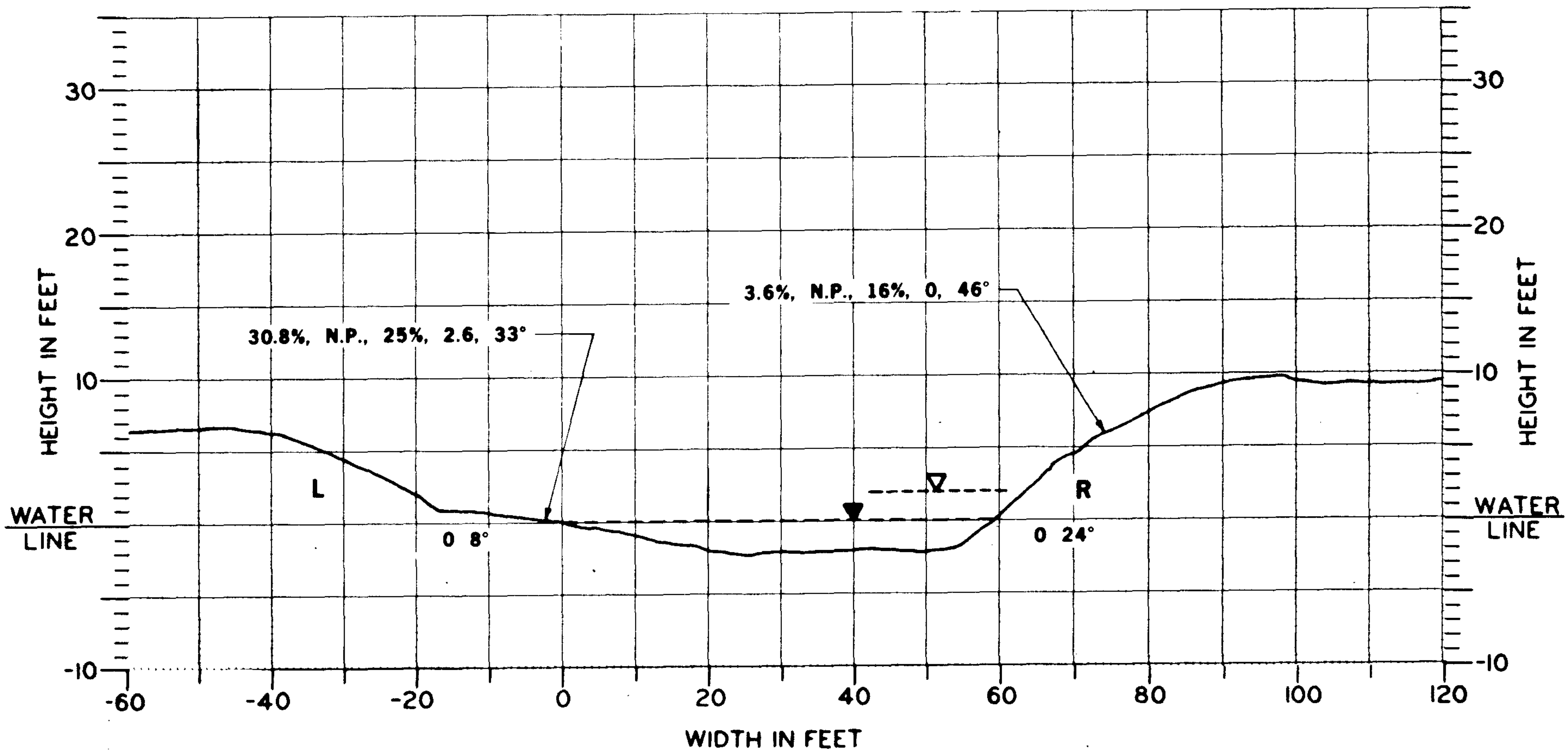
WIDTH OF STREAM (W-W) = 83.5 FT.
WIDTH OF BANKS (B-B) = 103.4 FT.
MEASURED DEPTH = 2.76 FT.



SITE NO. 47

HURON RIVER

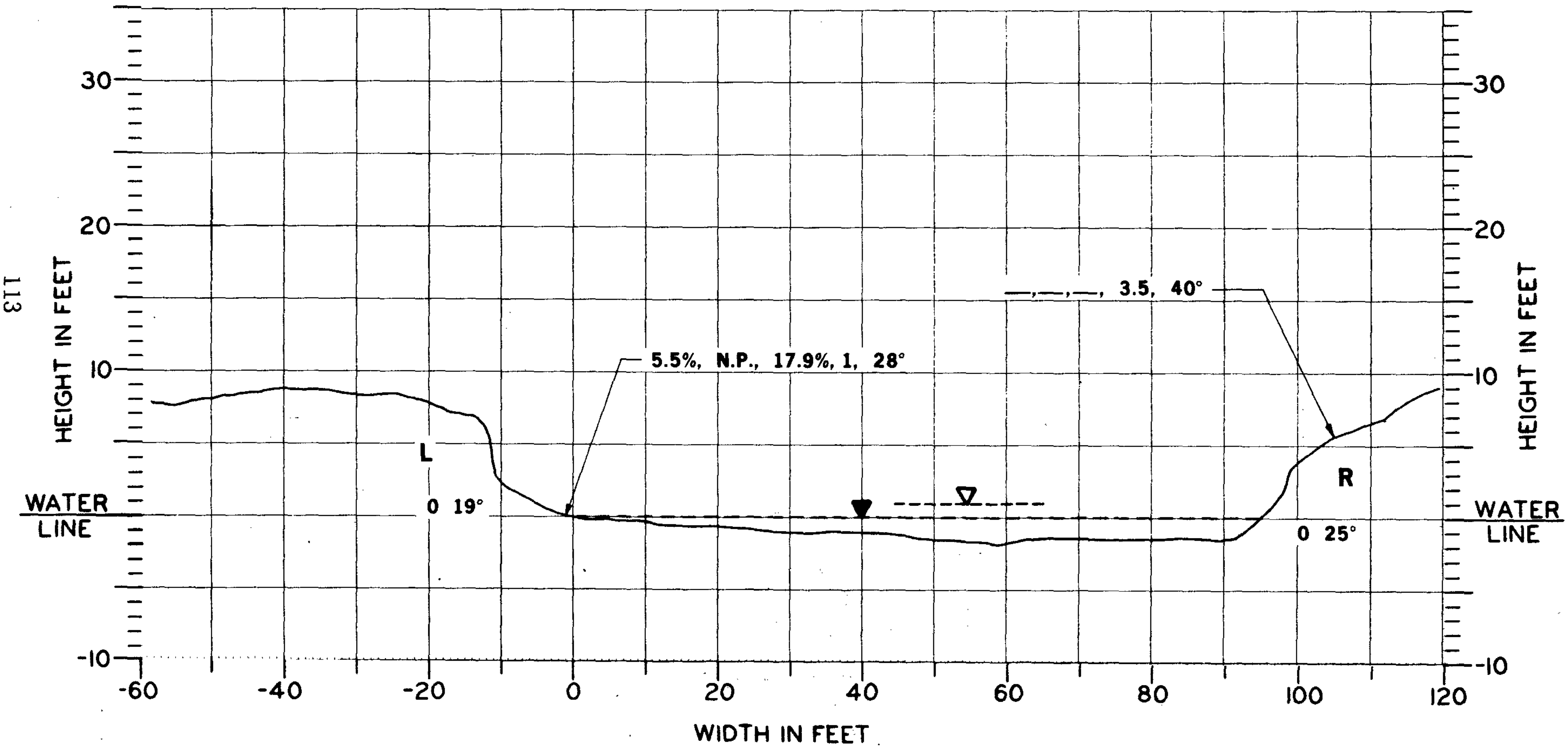
WIDTH OF STREAM (W-W) = 59.4 FT.
WIDTH OF BANKS (B-B) = 94.0 FT.
MEASURED DEPTH = 2.24 FT.



SITE NO. 48

HURON RIVER

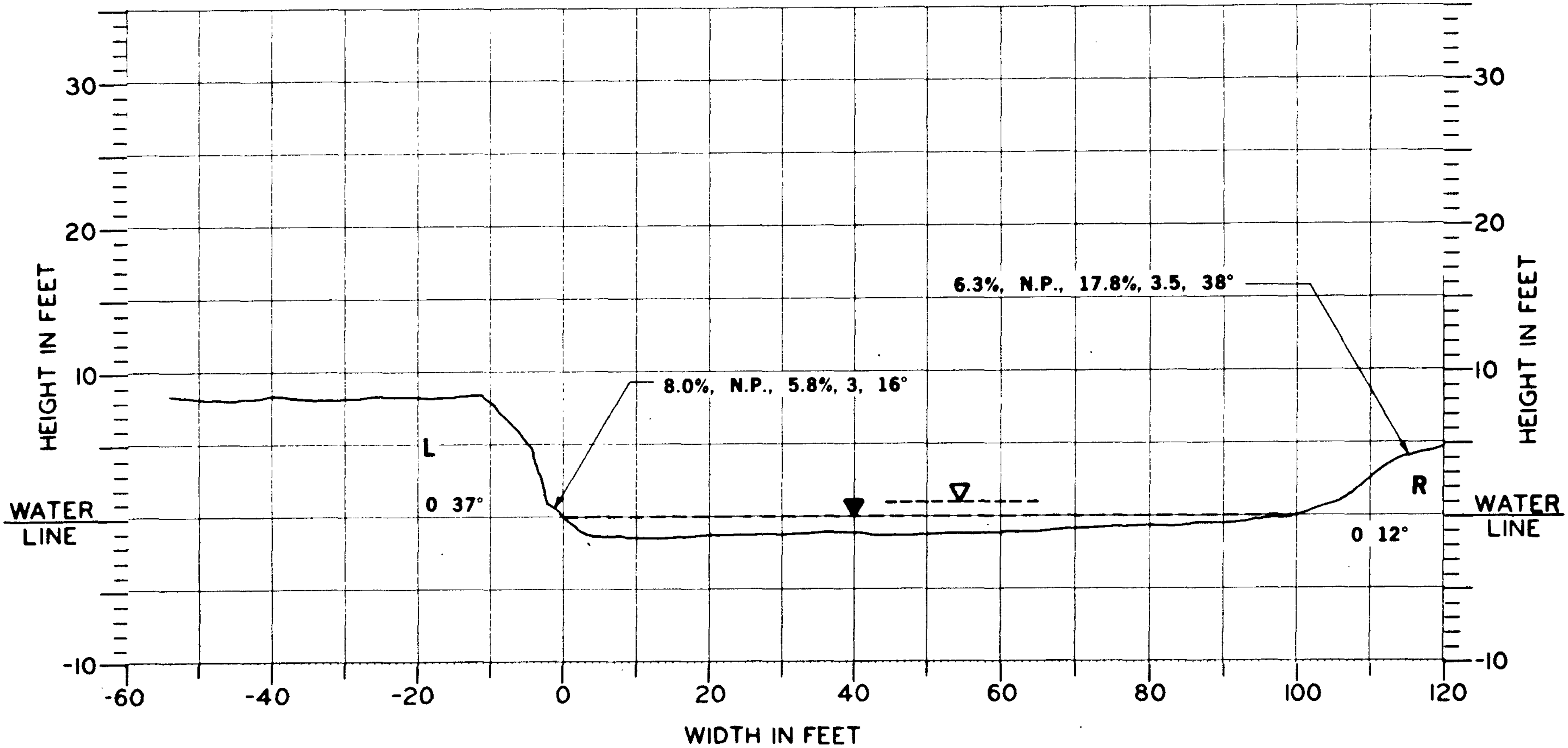
WIDTH OF STREAM (W-W) = 94.9 FT.
WIDTH OF BANKS (B-B) = 118.5 FT.
MEASURED DEPTH = 1.86 FT.



SITE NO. 49

HURON RIVER

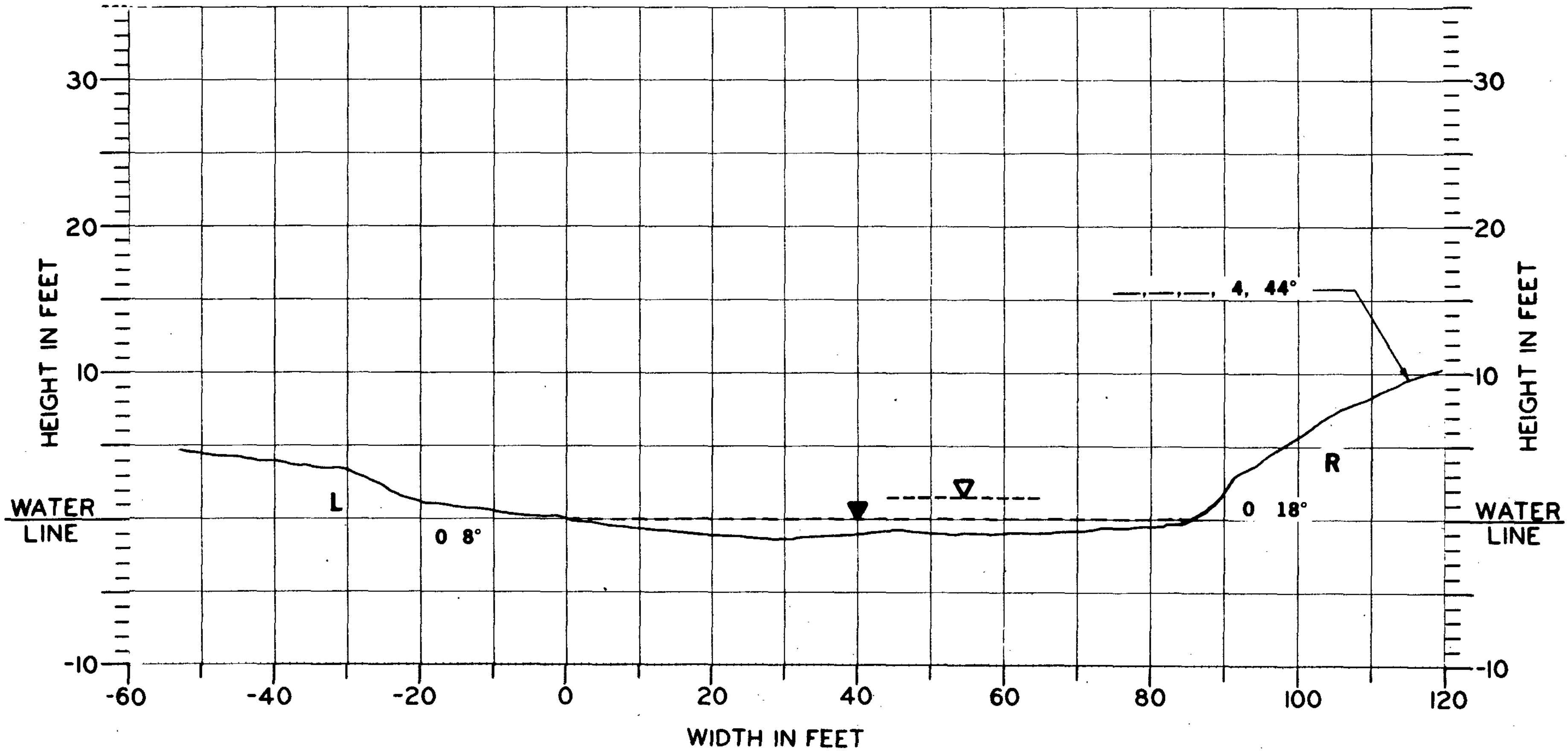
WIDTH OF STREAM (W-W) = 100.4 FT.
WIDTH OF BANKS (B-B) = 125.5 FT.
MEASURED DEPTH = 1.29 FT.



SITE NO. 50

HURON RIVER

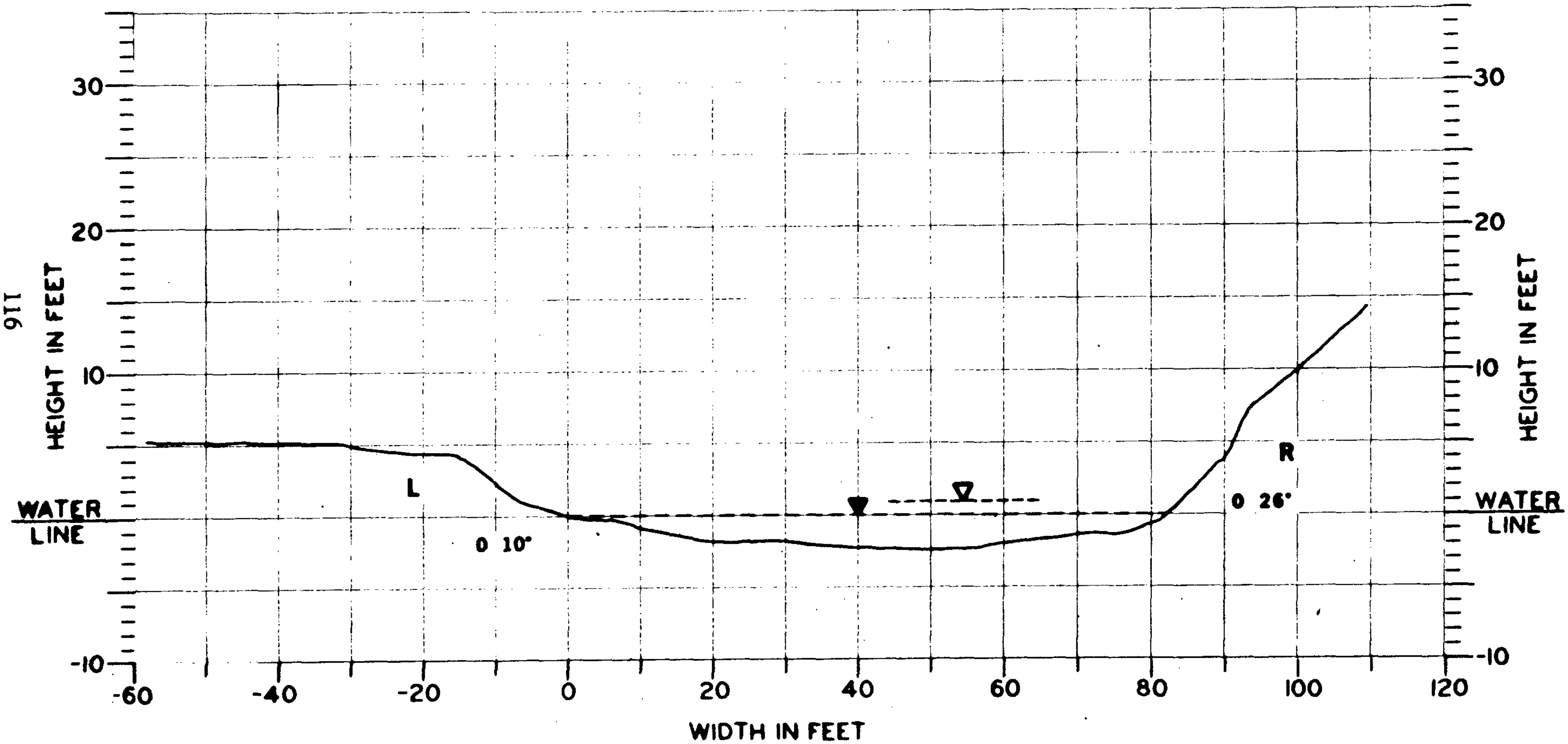
WIDTH OF STREAM (W-W) = 86.0 FT.
WIDTH OF BANKS (B-B) = 120.7 FT.
MEASURED DEPTH = 1.35 FT.



SITE NO. 51

HURON RIVER

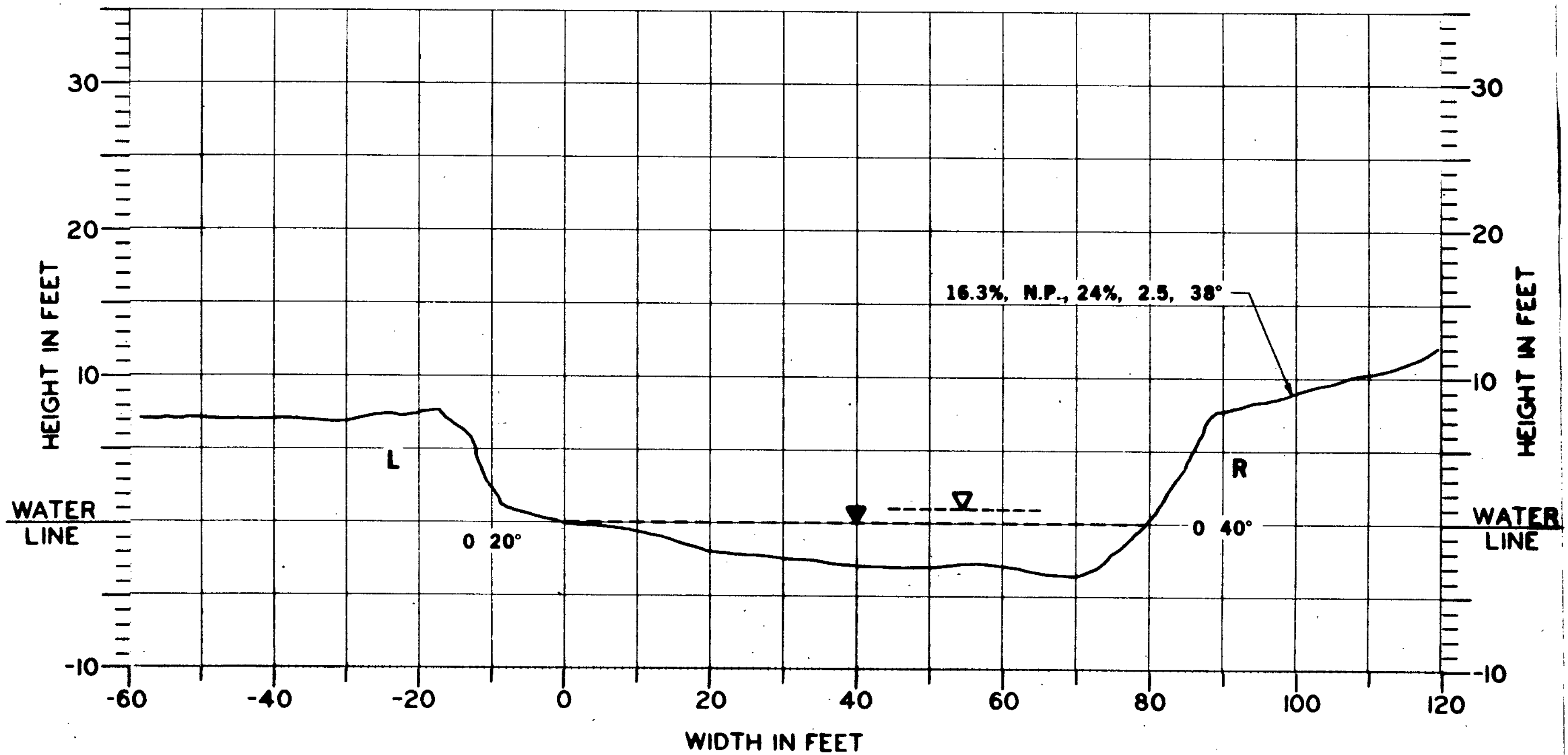
WIDTH OF STREAM (W-W) = 82 FT.
WIDTH OF BANKS (B-B) = 108.1 FT.
MEASURED DEPTH = 2.45 FT.



SITE NO. 52

HURON RIVER

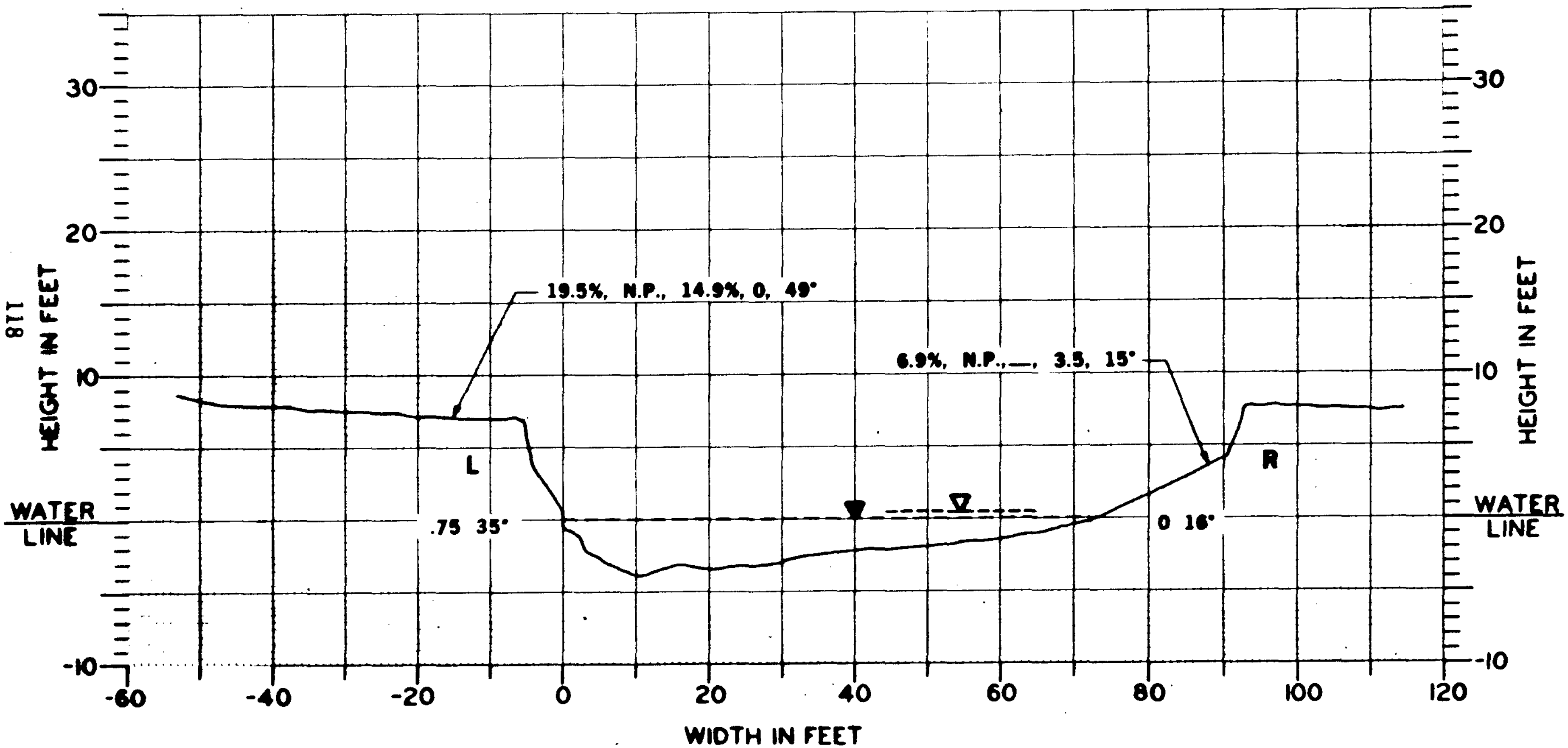
WIDTH OF STREAM (W-W) = 79.8 FT.
WIDTH OF BANKS (B-B) = 105.3 FT.
MEASURED DEPTH = 3.62 FT.



SITE NO. 53

HURON RIVER

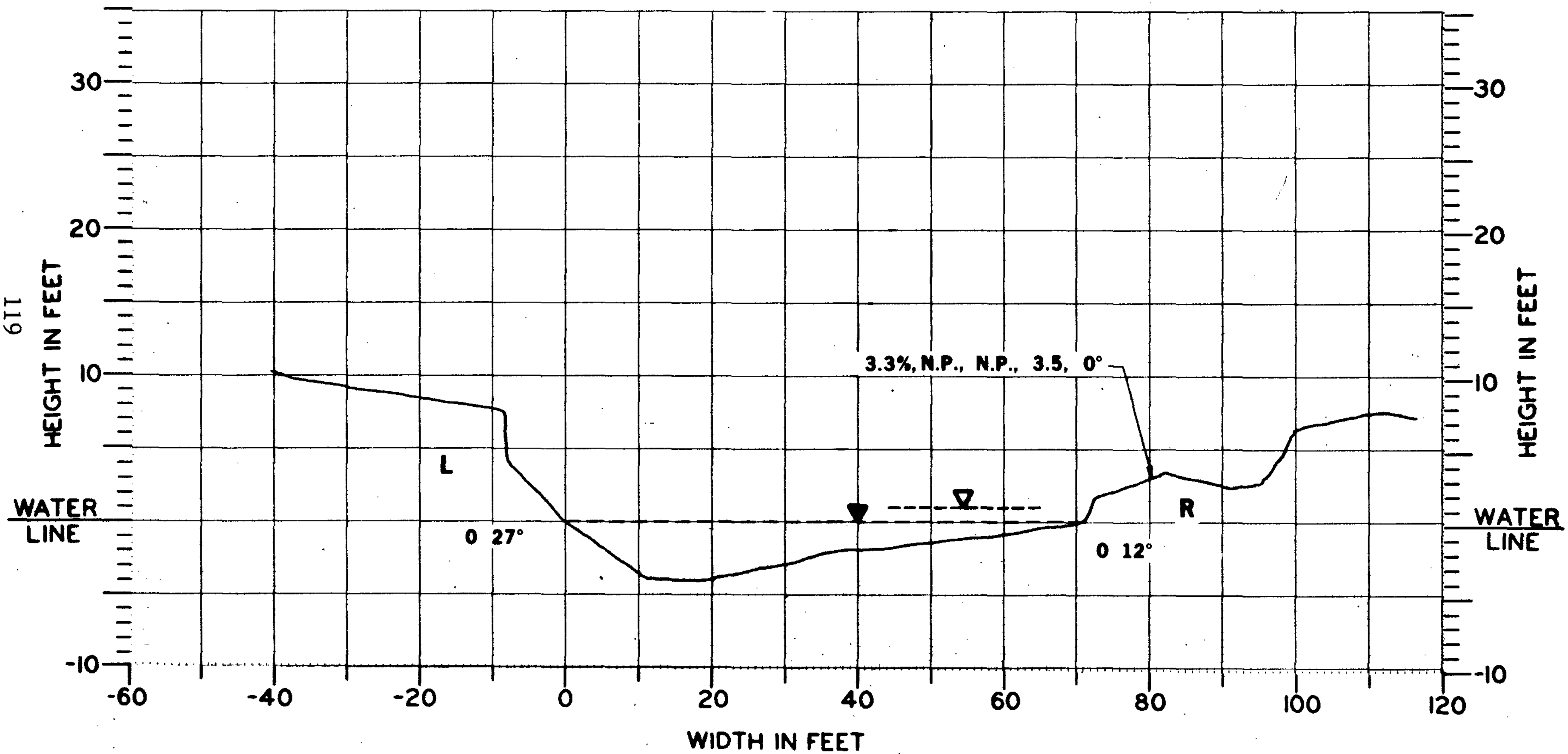
WIDTH OF STREAM (W-W) = 74.0 FT.
WIDTH OF BANKS (B-B) = 98.2 FT.
MEASURED DEPTH = 3.90 FT.



SITE NO. 54

HURON RIVER

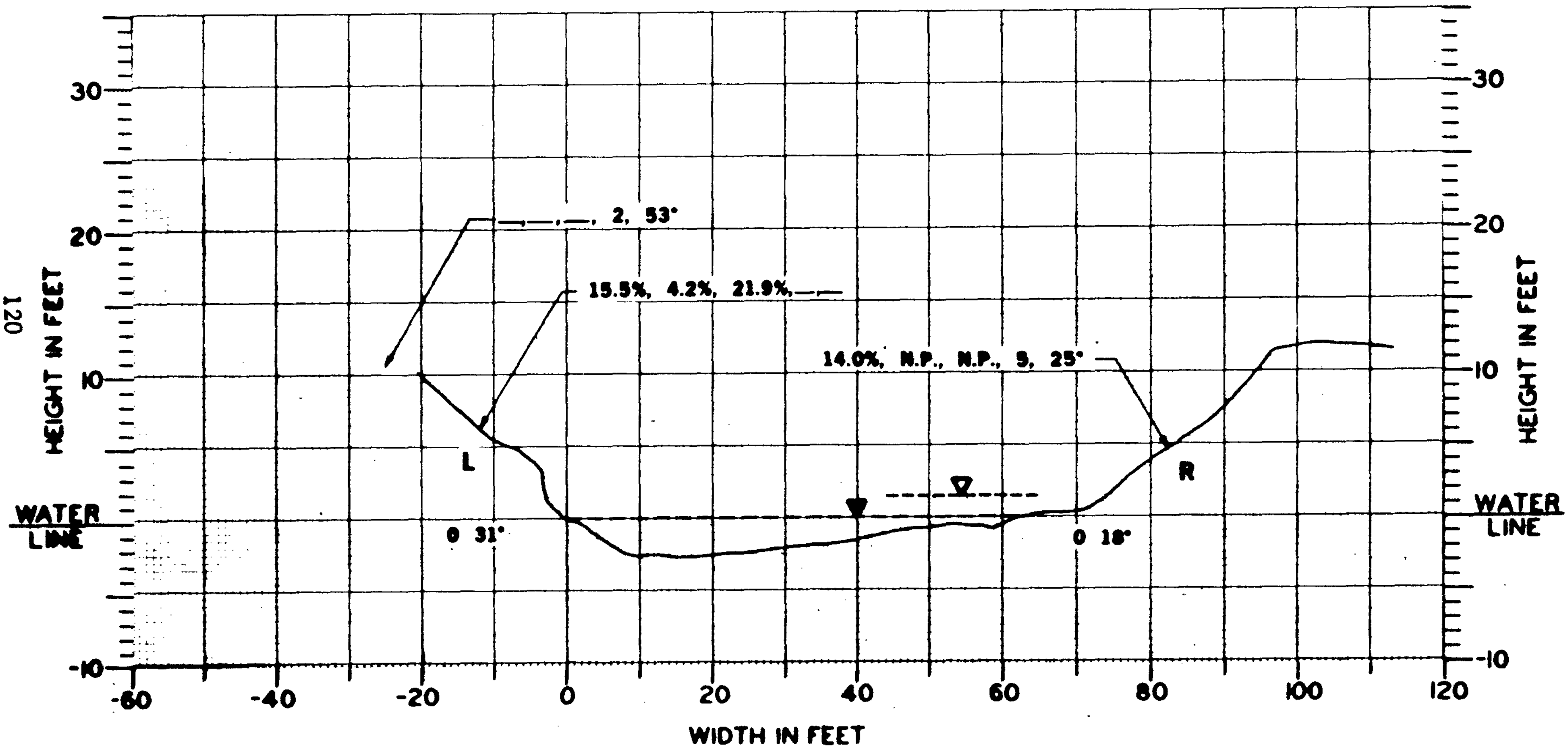
WIDTH OF STREAM (W-W) = 70.9 FT.
WIDTH OF BANKS (B-B) = 119.3 FT.
MEASURED DEPTH = 3.97 FT.



SITE NO. 55

HURON RIVER

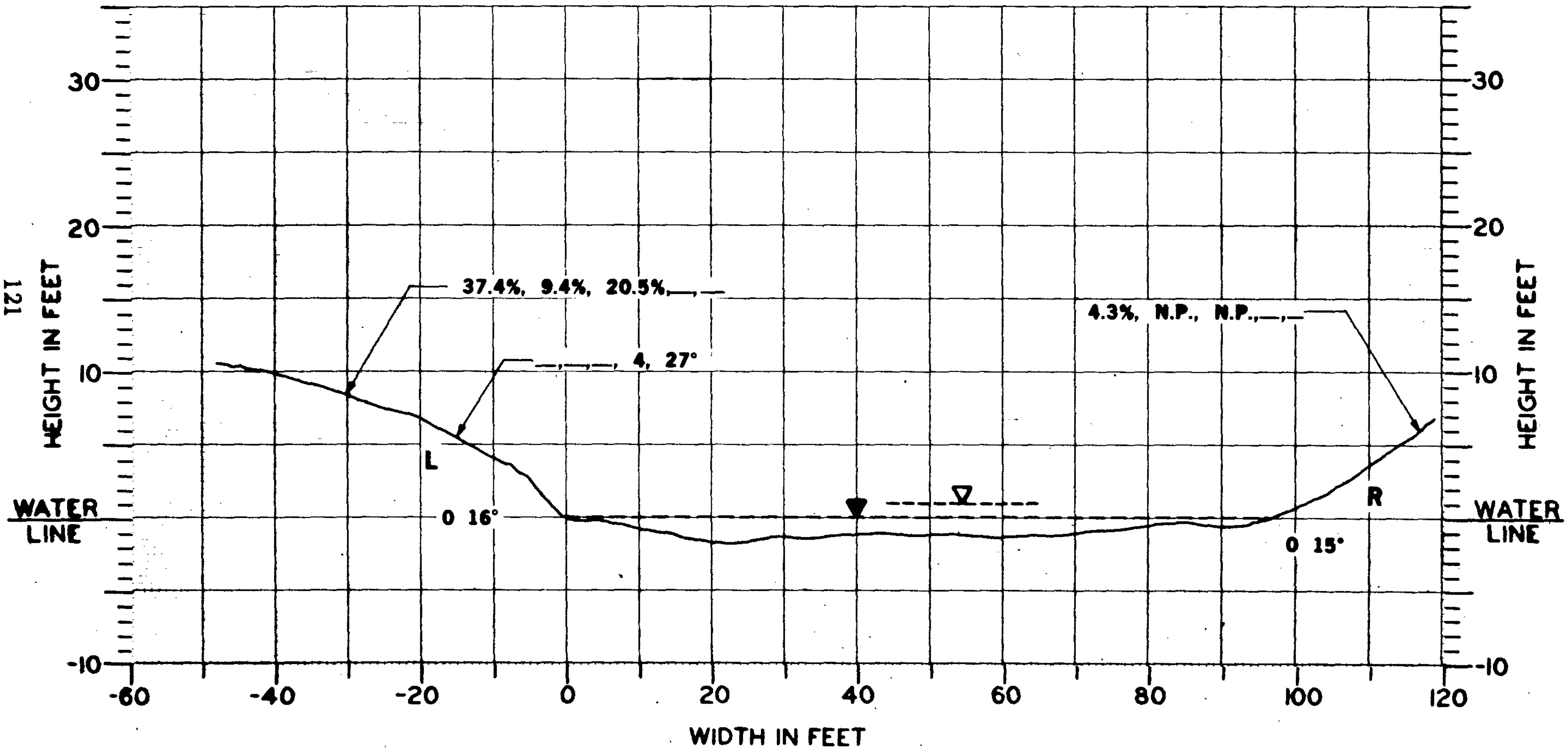
WIDTH OF STREAM (W-W) = 61.5 FT.
WIDTH OF BANKS (B-B) = 100.2 FT.
MEASURED DEPTH = 2.66 FT.



SITE NO. 56

HURON RIVER

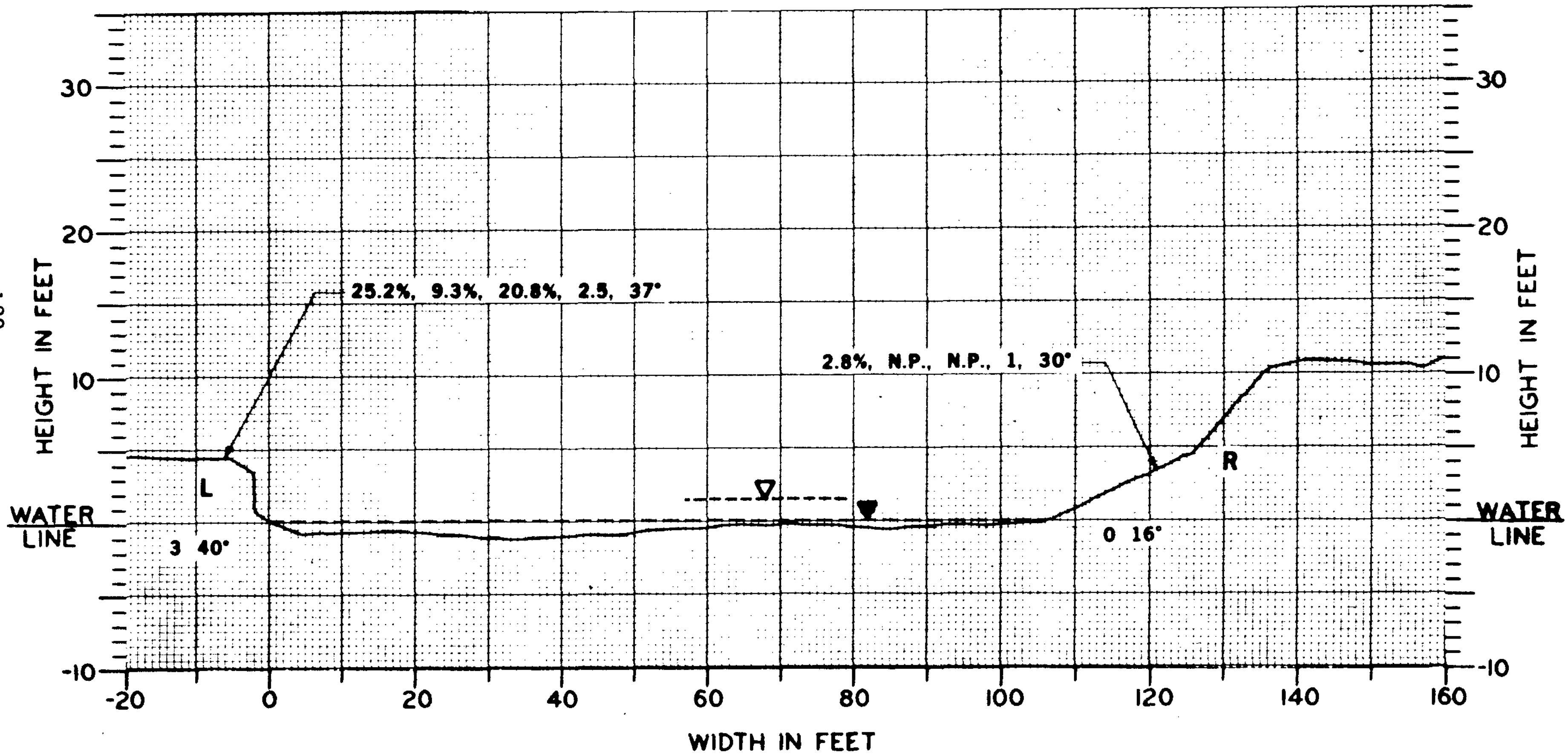
WIDTH OF STREAM (W-W) = 96.5 FT.
WIDTH OF BANKS (B-B) = 133.9 FT.
MEASURED DEPTH = 1.70 FT.



SITE NO. 57

HURON RIVER

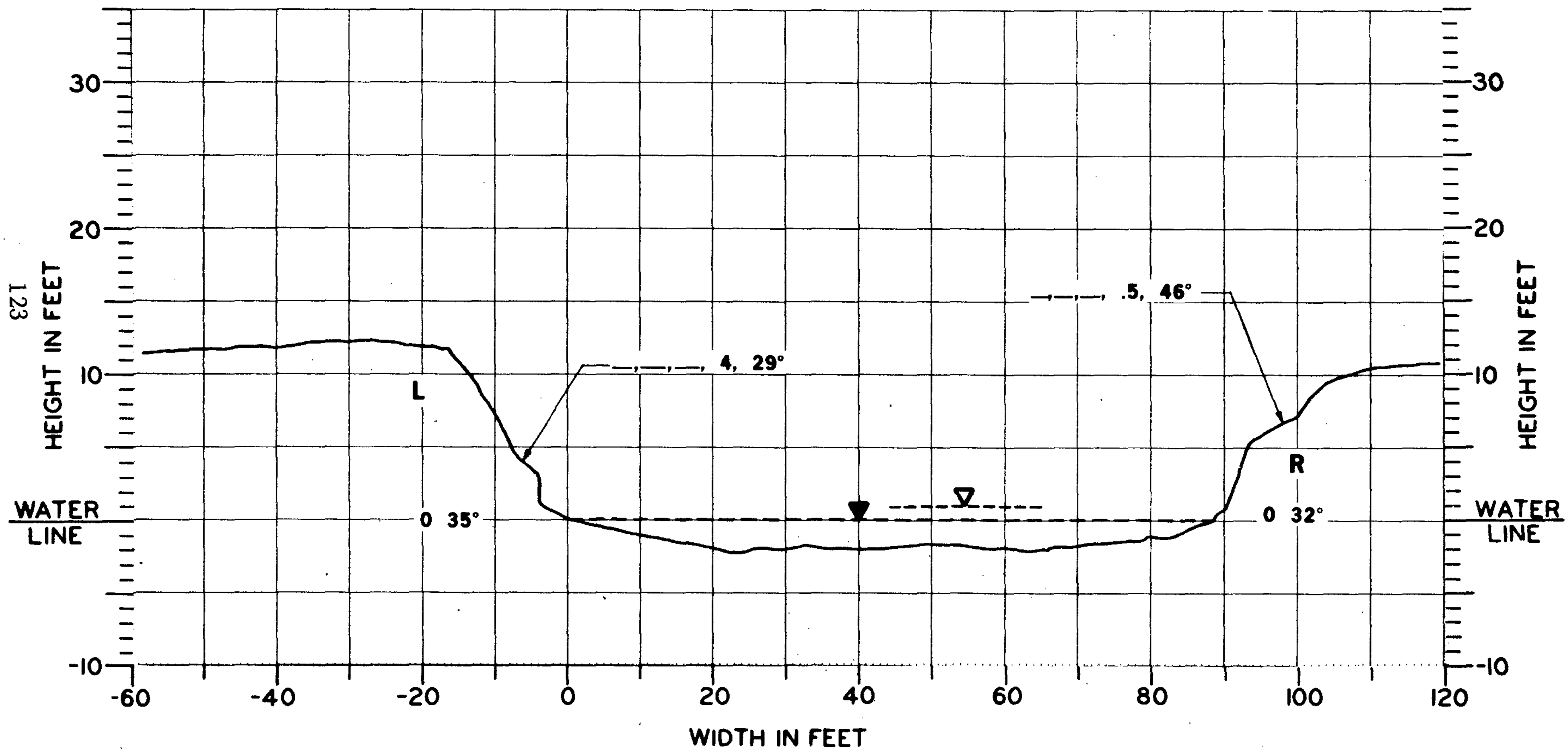
WIDTH OF STREAM (W-W) = 106.5 FT.
WIDTH OF BANKS (B-B) = 138.0 FT.
MEASURED DEPTH = 1.18 FT.



SITE NO. 58

HURON RIVER

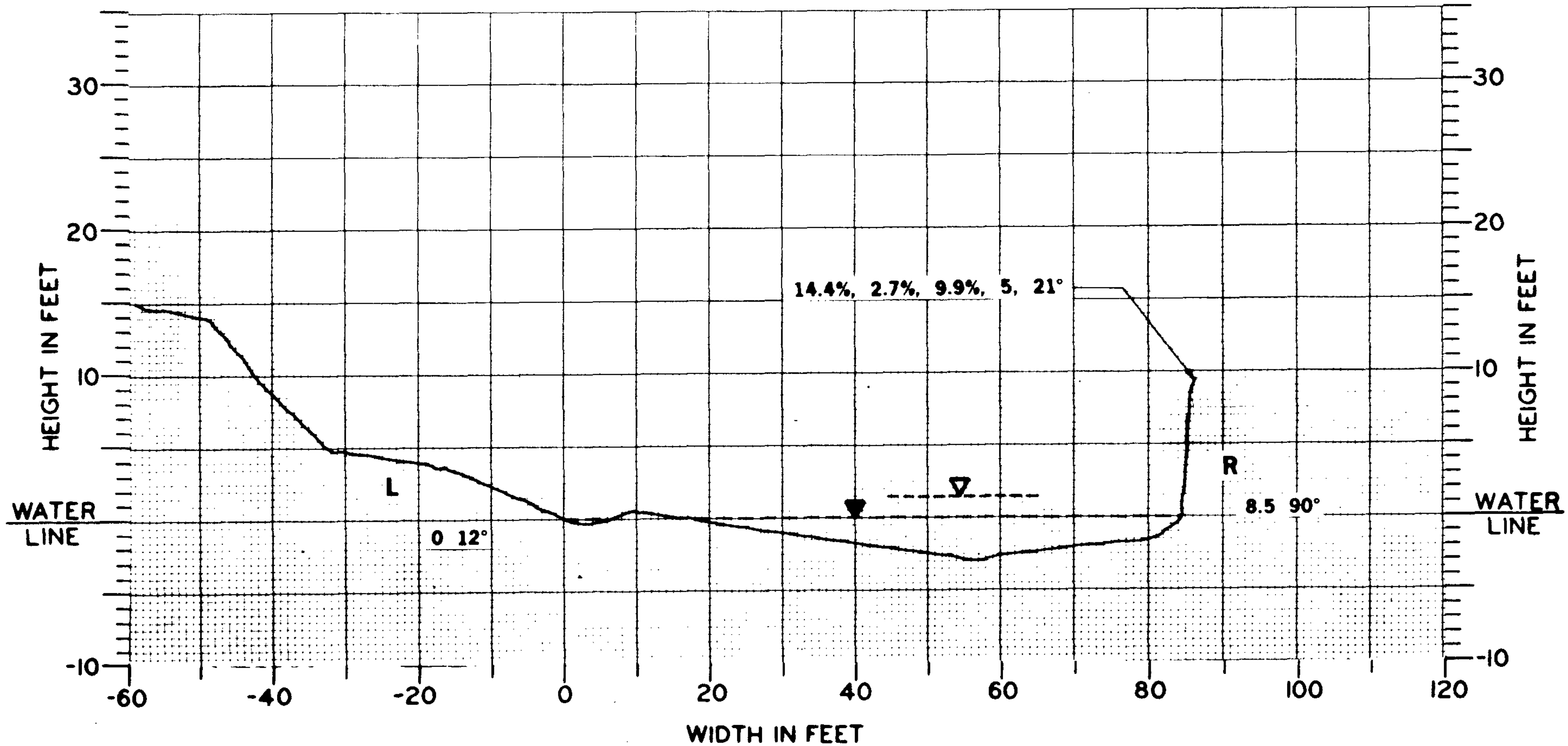
WIDTH OF STREAM (W-W) = 88.5 FT.
WIDTH OF BANKS (B-B) = 109.4 FT.
MEASURED DEPTH = 2.36 FT.



SITE NO. 59

HURON RIVER

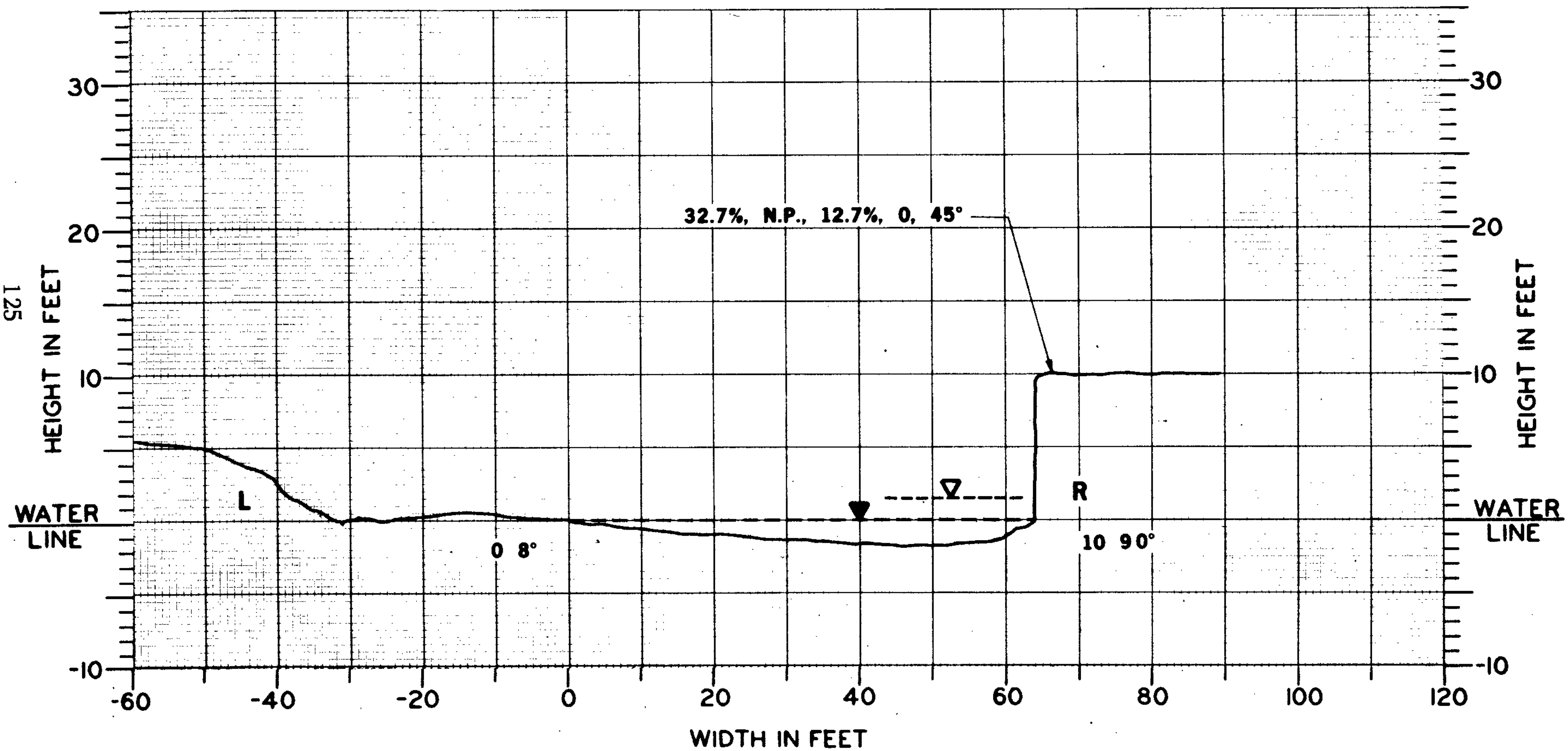
WIDTH OF STREAM (W-W) = 84.6 FT.
WIDTH OF BANKS (B-B) = 92.1 FT.
MEASURED DEPTH = 2.96 FT.



SITE NO. 60

HURON RIVER

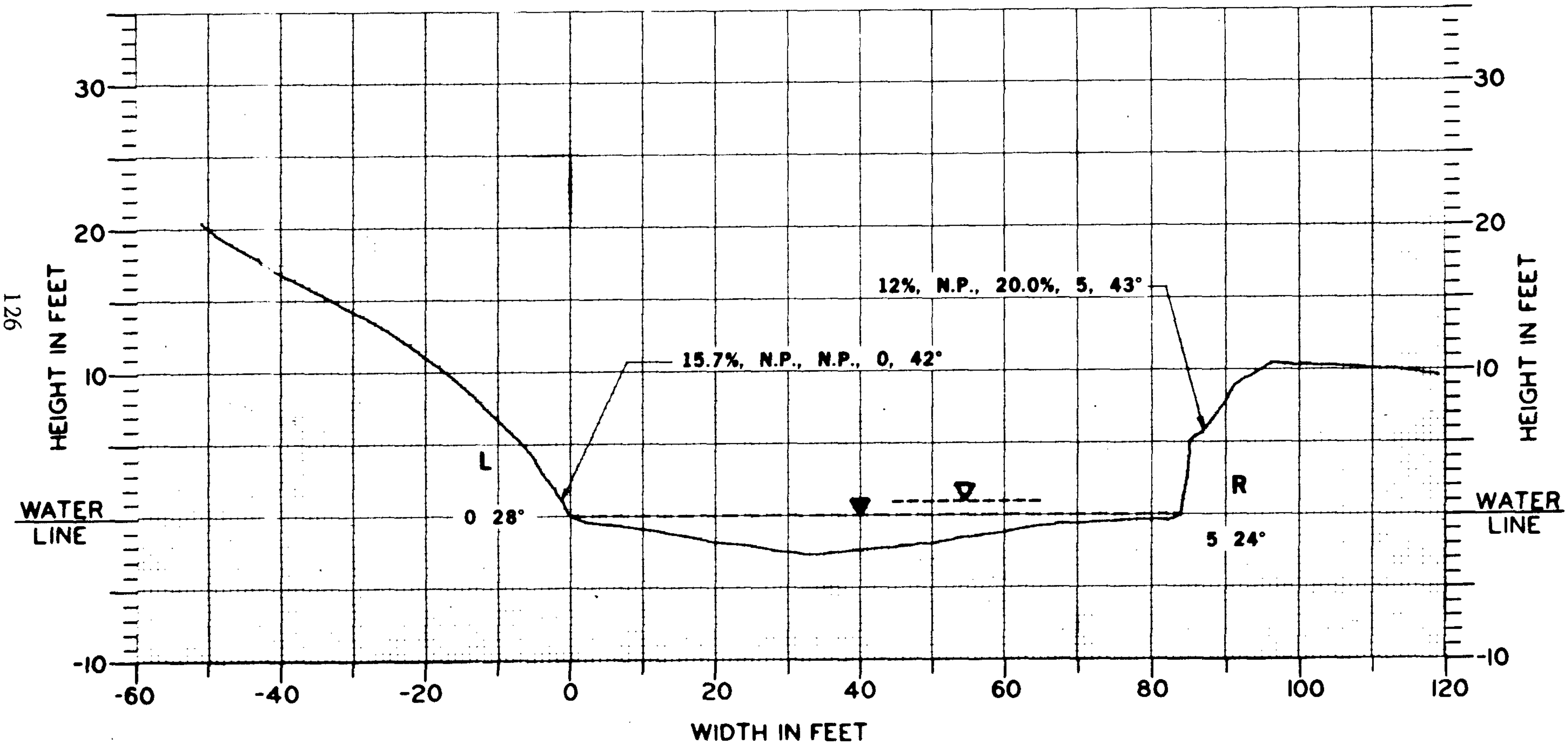
WIDTH OF STREAM (W-W) = 63.8 FT.
WIDTH OF BANKS (B-B) = 104.5 FT.
MEASURED DEPTH = 1.84 FT.



SITE NO. 61

HURON RIVER

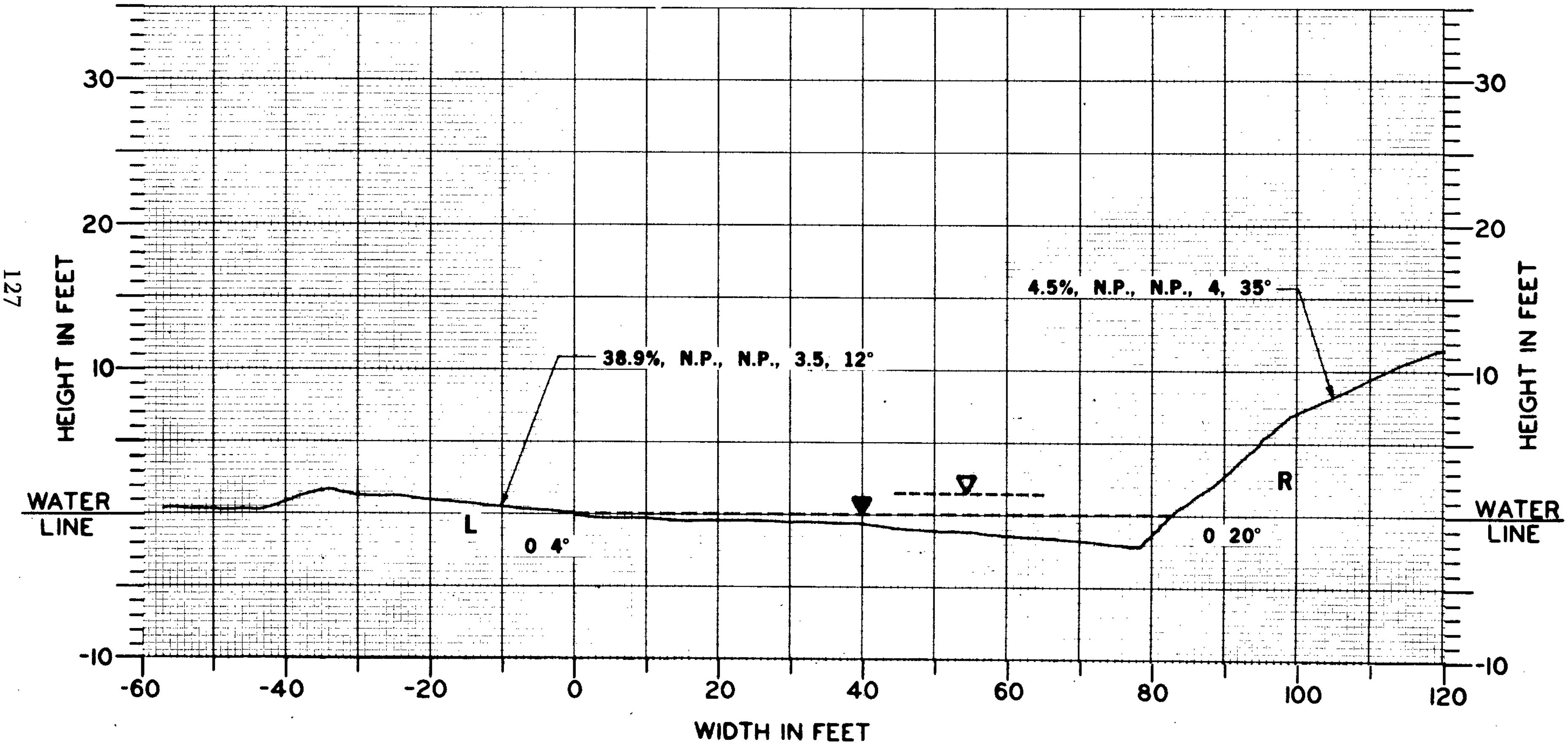
WIDTH OF STREAM (W-W) = 84.0 FT.
WIDTH OF BANKS (B-B) = 91.5 FT.
MEASURED DEPTH = 2.53 FT.



SITE NO. 62

HURON RIVER

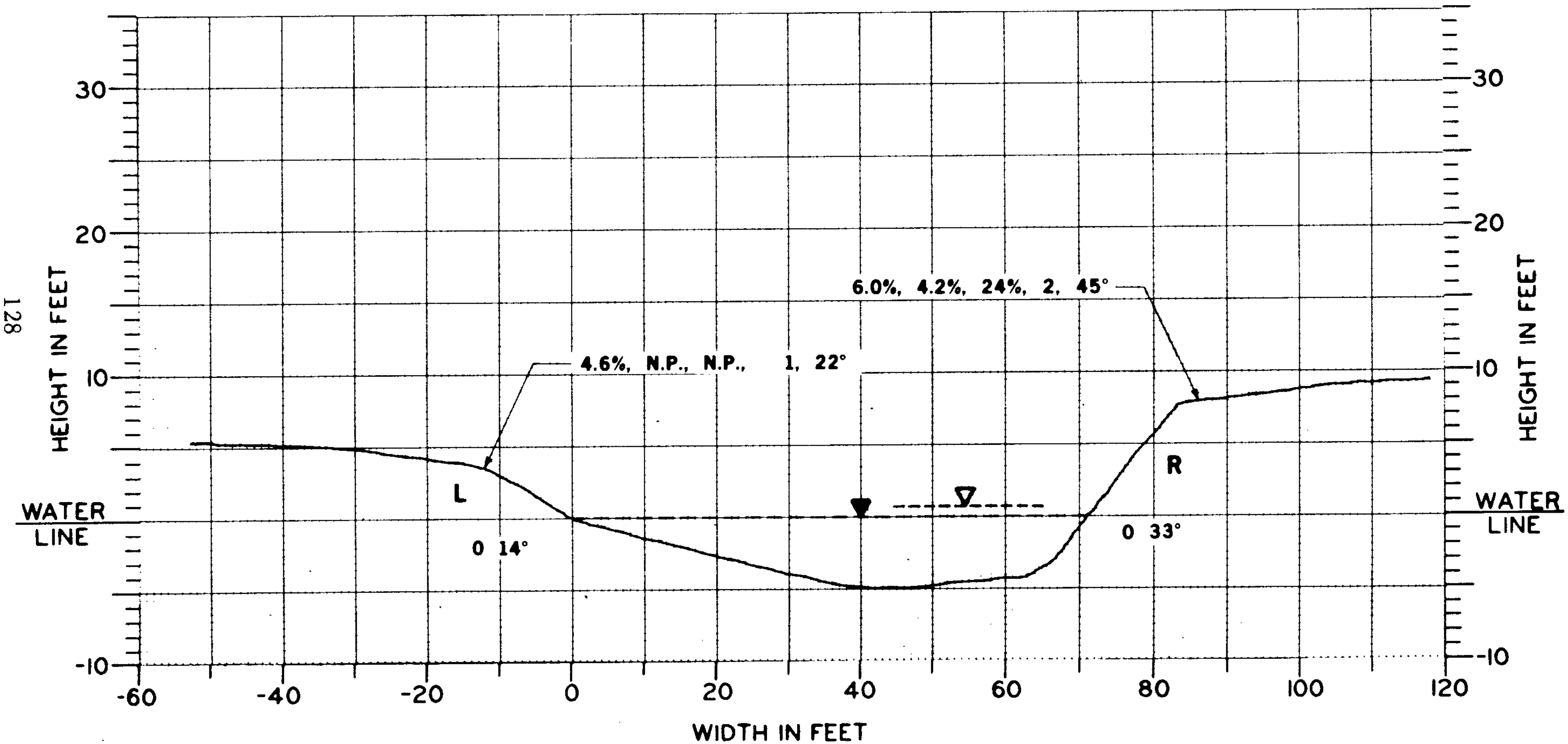
WIDTH OF STREAM (W-W) = 83.0 FT.
WIDTH OF BANKS (B-B) = 153.6 FT.
MEASURED DEPTH = 2.11 FT.



SITE NO. 63

HURON RIVER

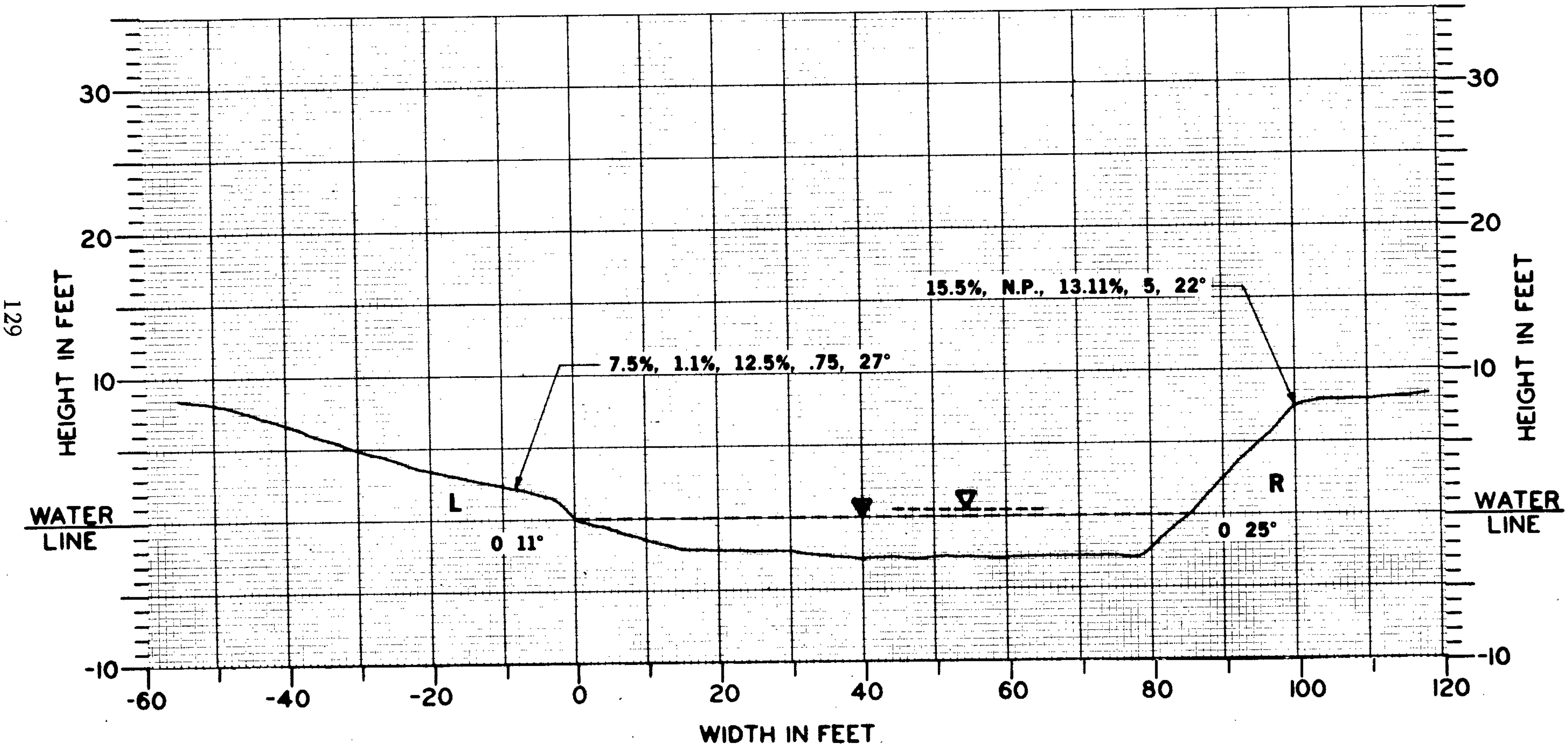
WIDTH OF STREAM (W-W) = 71.1 FT.
WIDTH OF BANKS (B-B) = 90.1 FT.
MEASURED DEPTH = 5.04 FT.



SITE NO. 64

HURON RIVER

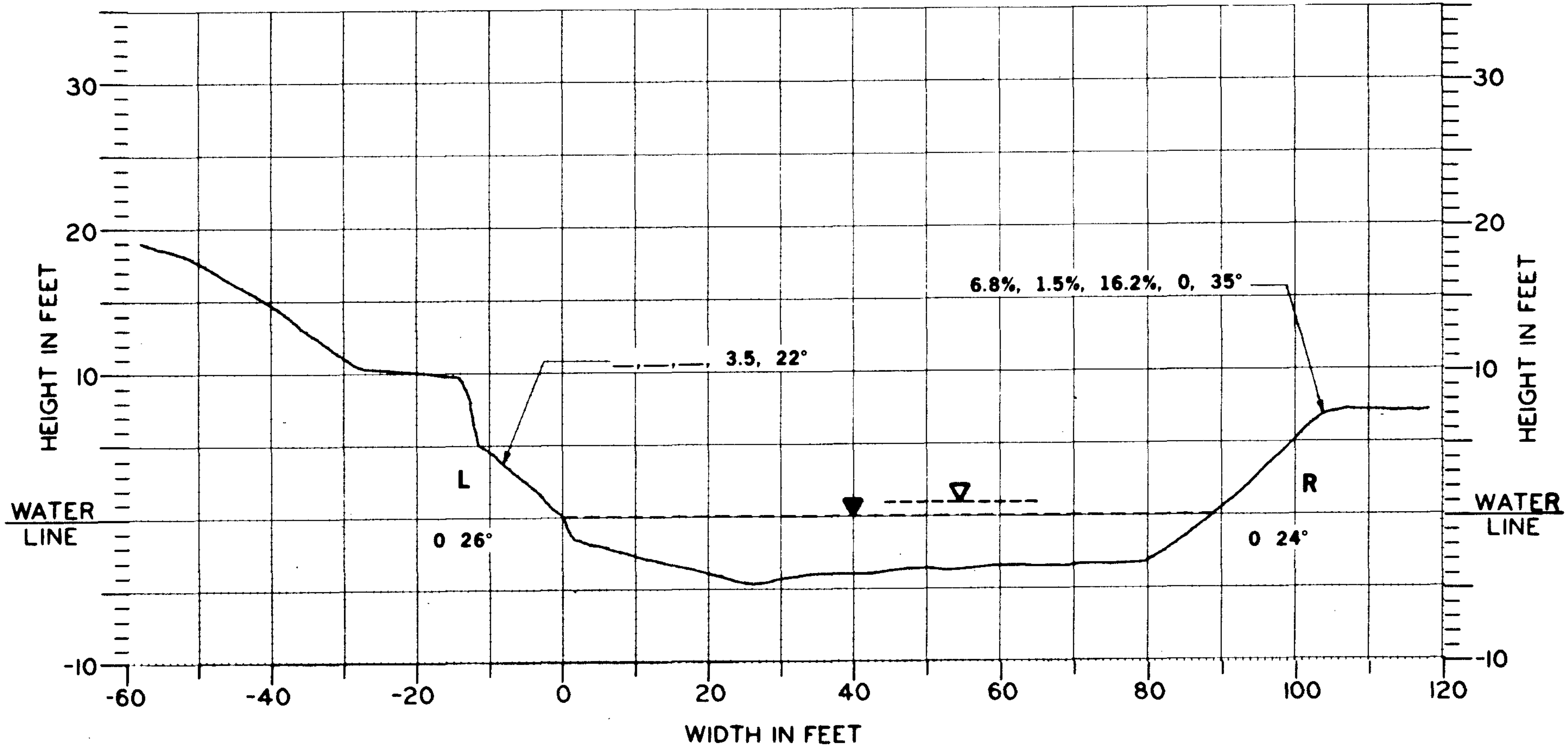
WIDTH OF STREAM (W-W) = 84.9 FT.
WIDTH OF BANKS (B-B) = 103.1 FT.
MEASURED DEPTH = 2.86 FT.



SITE NO. 65

HURON RIVER

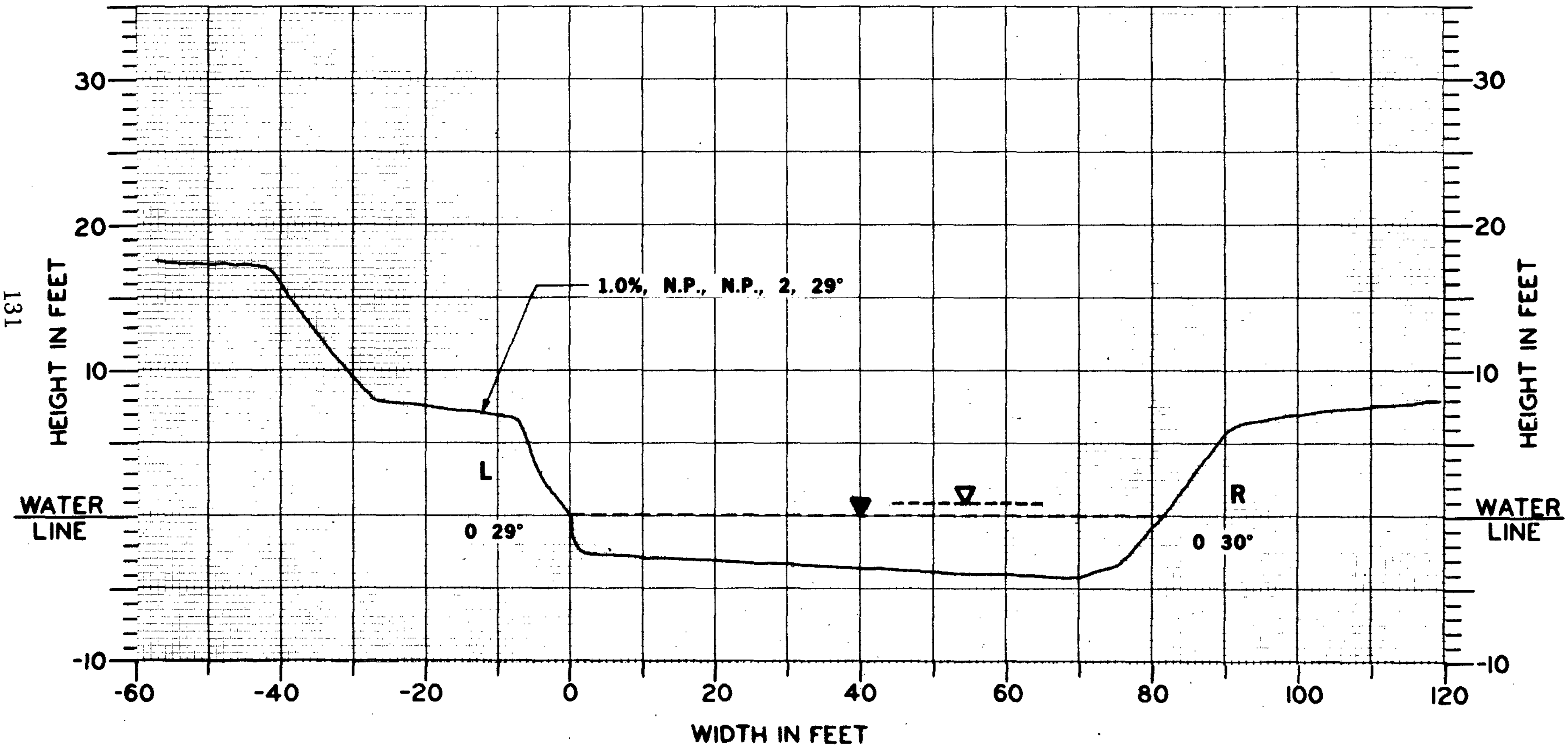
WIDTH OF STREAM (W-W) = 88.7 FT.
WIDTH OF BANKS (B-B) = 117.5 FT.
MEASURED DEPTH = 4.60 FT.



SITE NO. 66

HURON RIVER

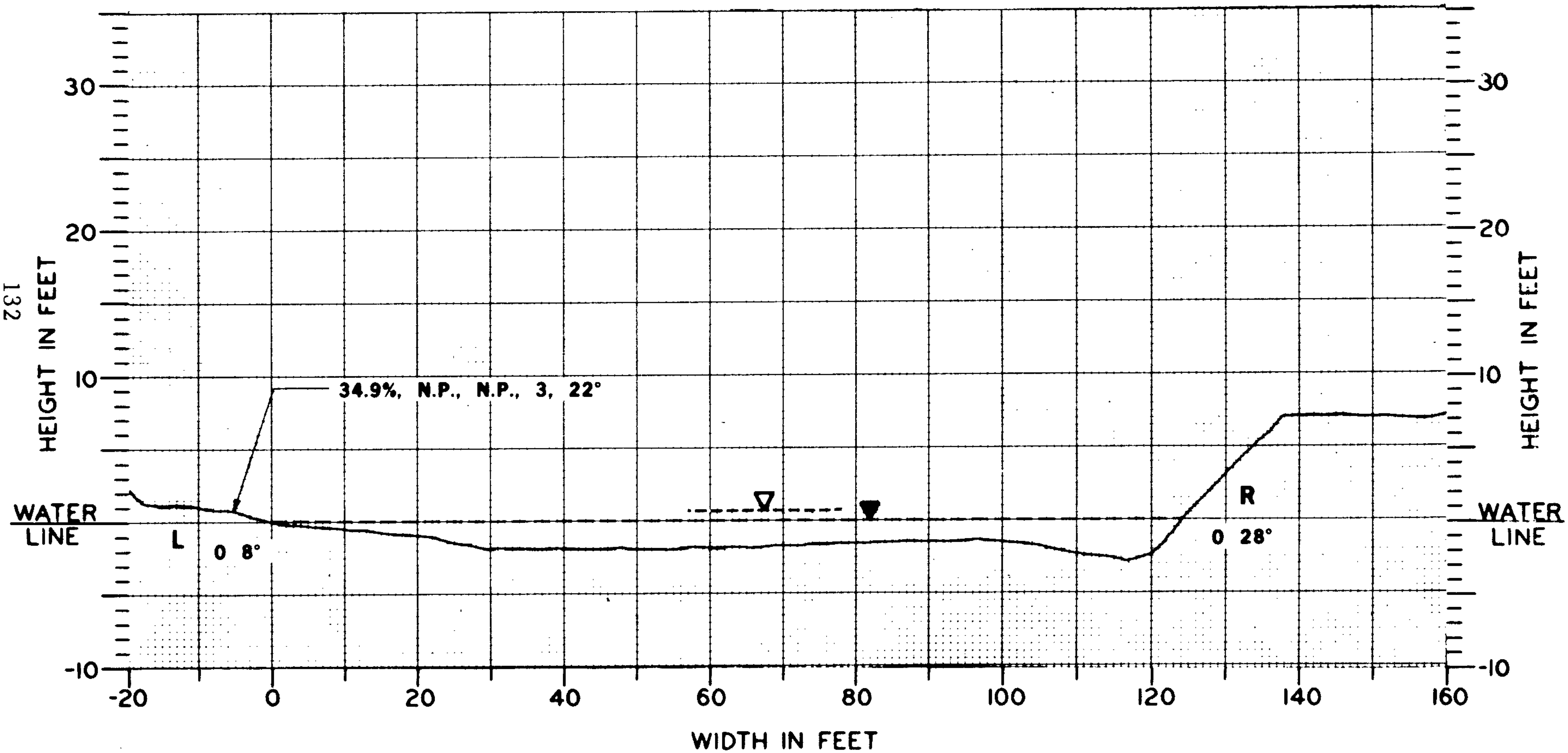
WIDTH OF STREAM (W-W) = 81.5 FT.
WIDTH OF BANKS (B-B) = 97.7 FT.
MEASURED DEPTH = 4.30 FT.



SITE NO. 67

HURON RIVER

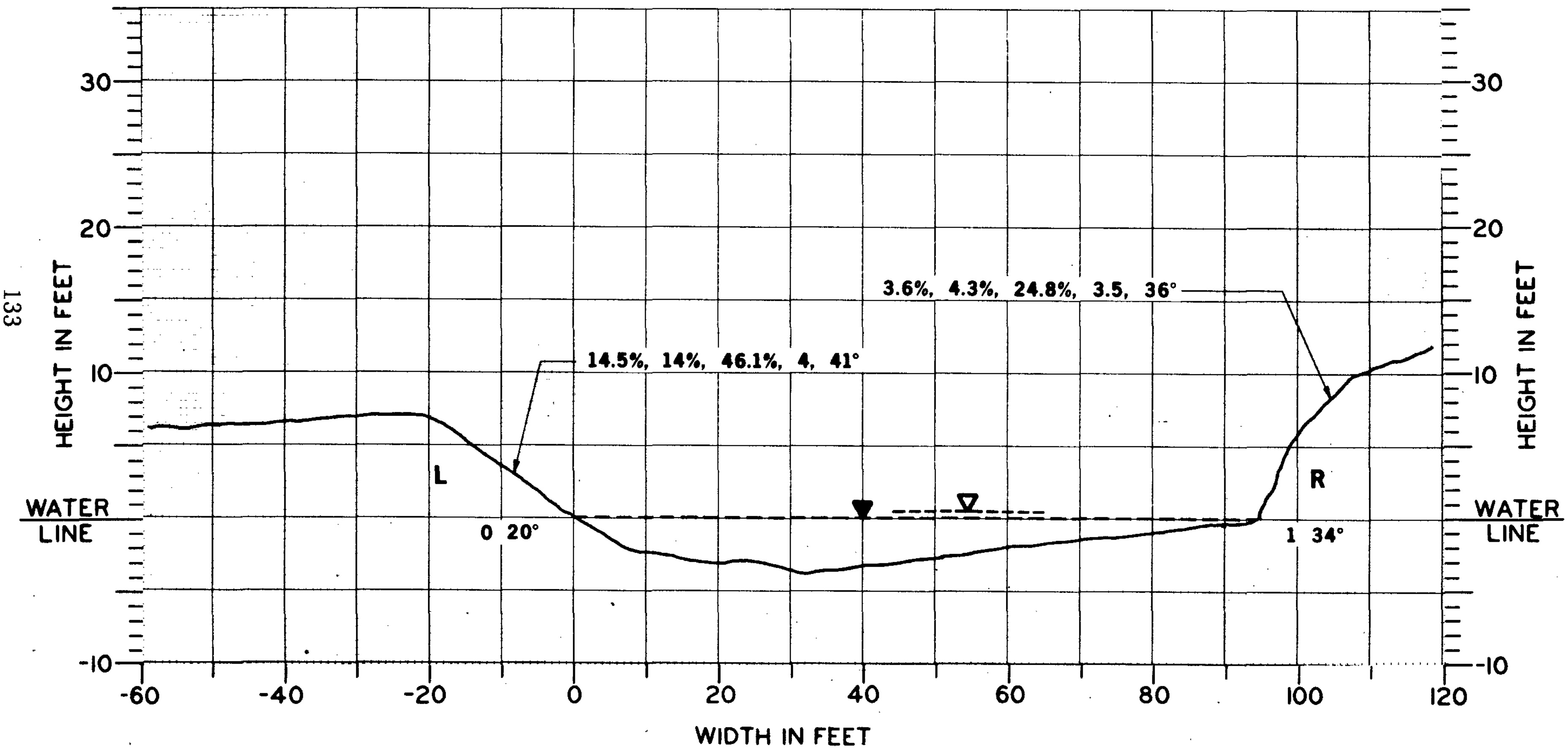
WIDTH OF STREAM (W-W) = 124 FT.
WIDTH OF BANKS (B-B) = 144.5 FT.
MEASURED DEPTH = 2.95 FT.



SITE NO. 68

HURON RIVER

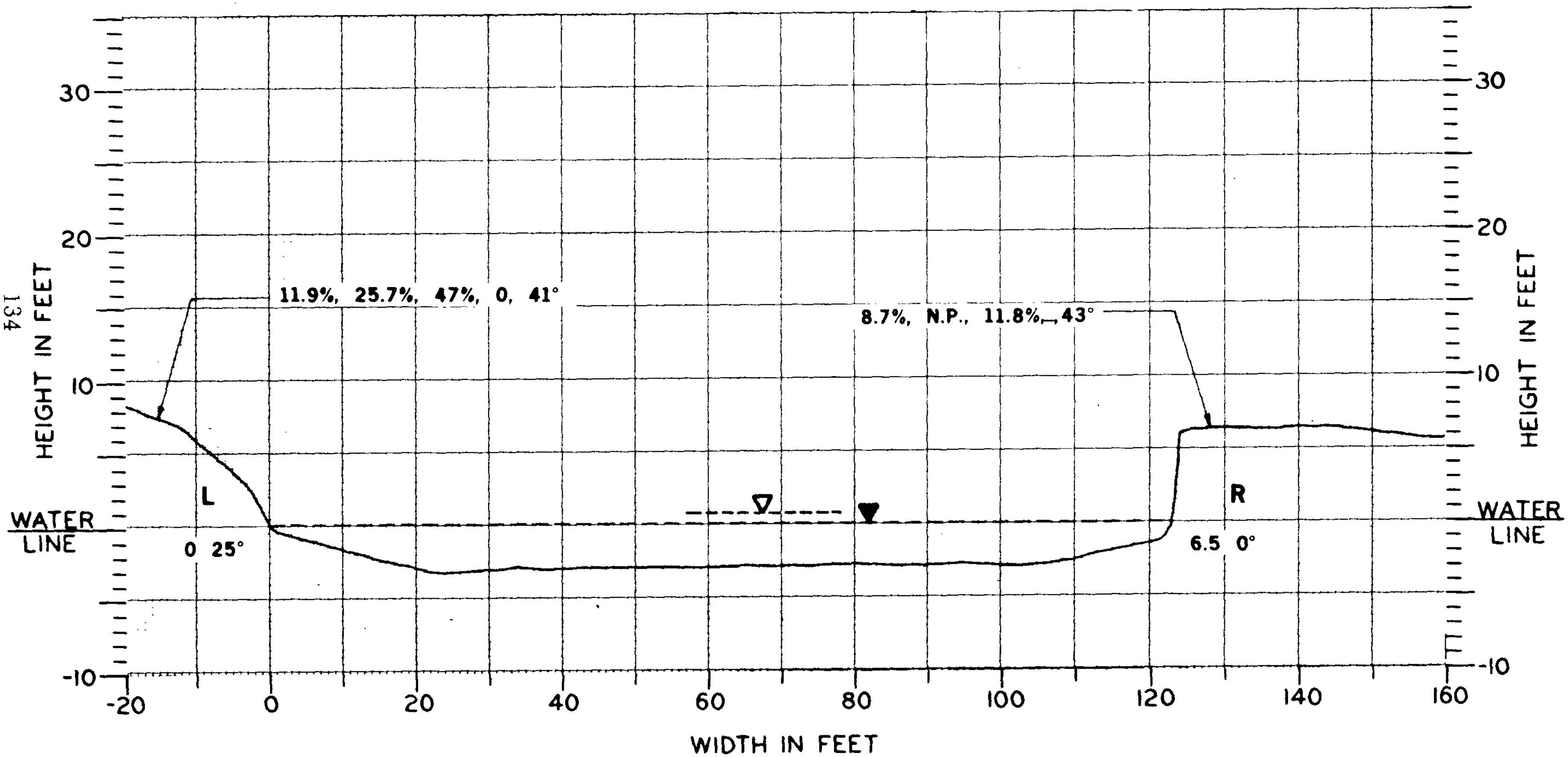
WIDTH OF STREAM (W-W) = 94.5 FT.
WIDTH OF BANKS (B-B) = 118.4 FT.
MEASURED DEPTH = 3.65 FT.



SITE NO. 69

HURON RIVER

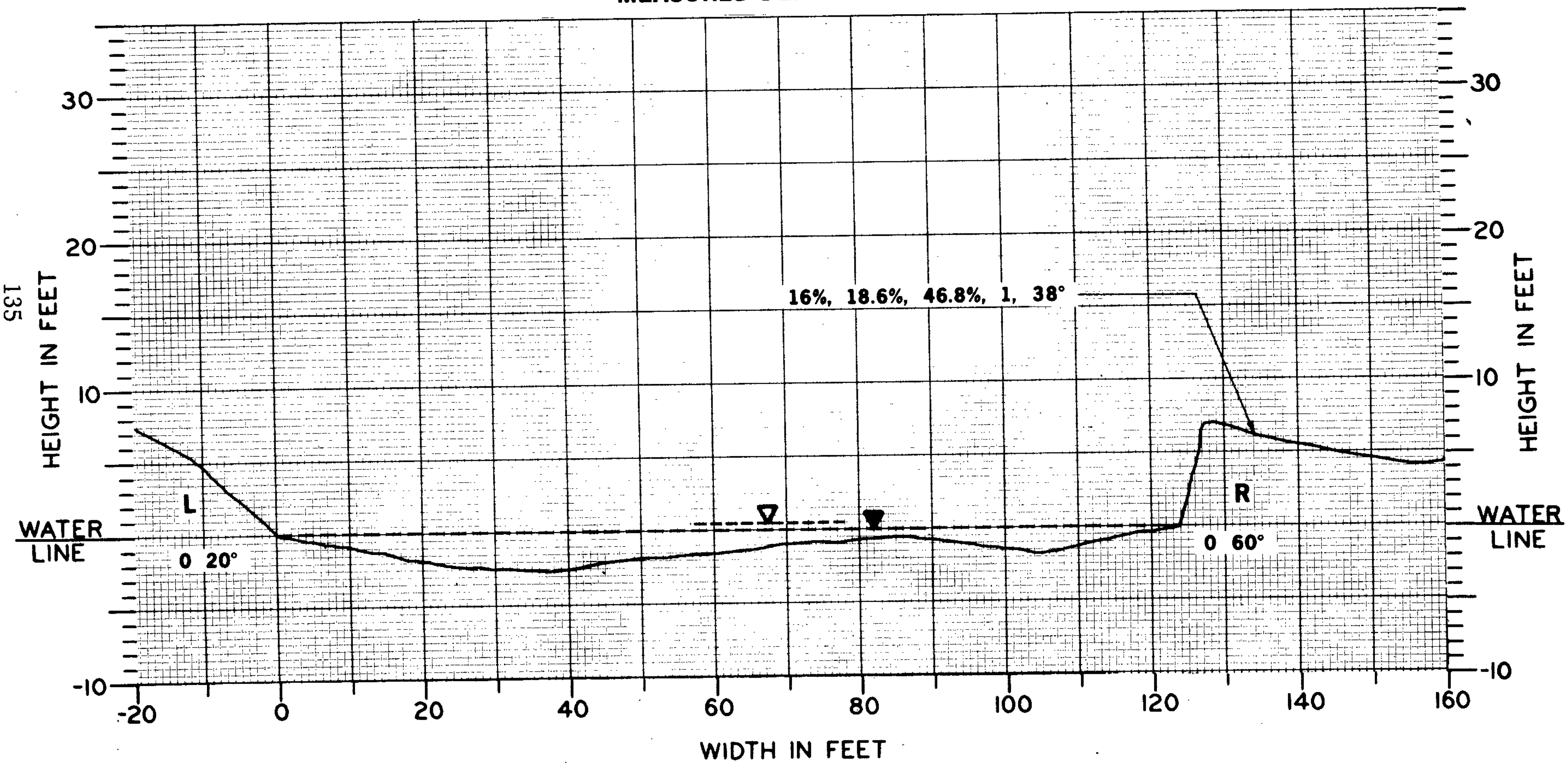
WIDTH OF STREAM (W-W) = 123 FT.
WIDTH OF BANKS (B-B) = 127 FT.
MEASURED DEPTH = 3.28 FT.



SITE NO. 70

HURON RIVER

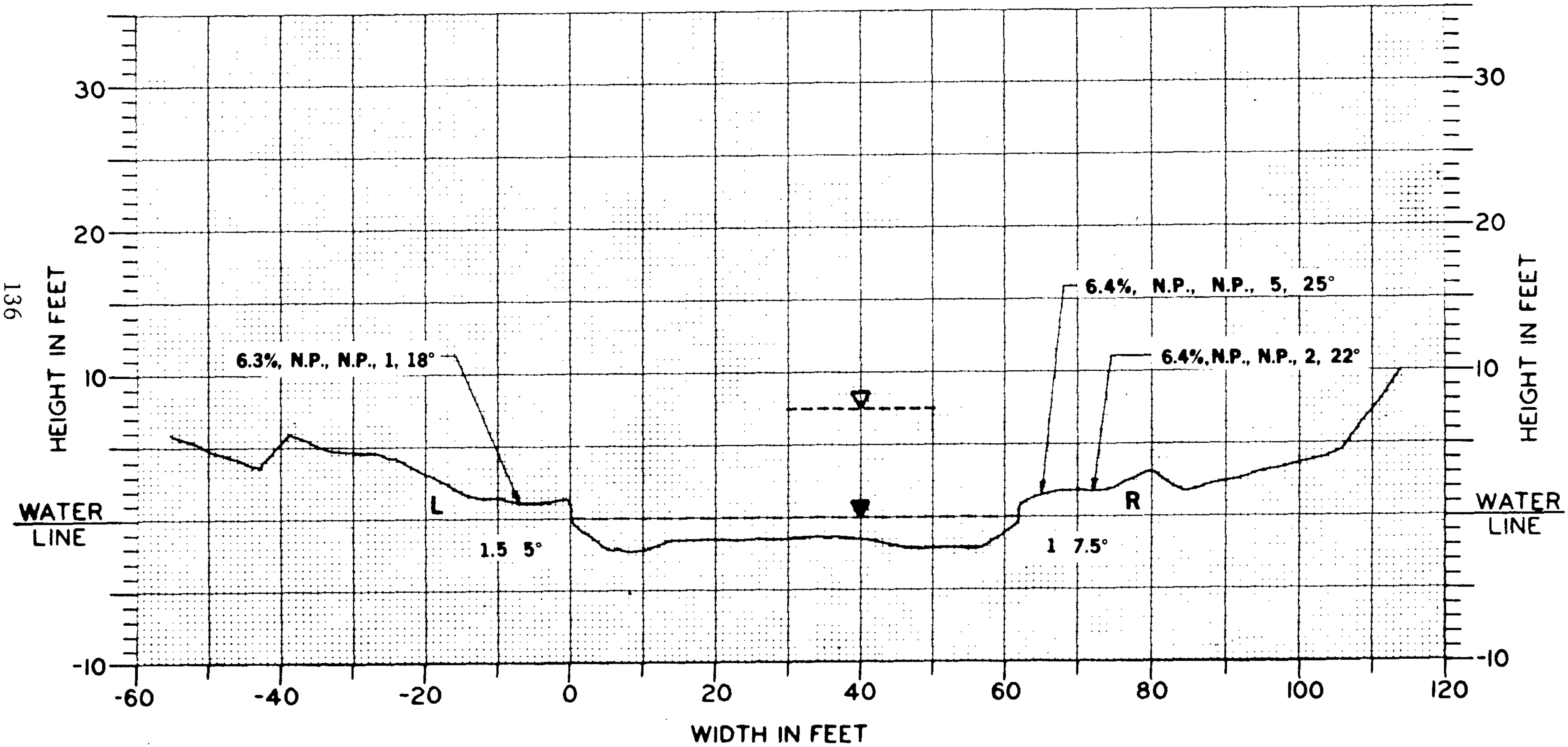
WIDTH OF STREAM (W-W) = 124 FT.
WIDTH OF BANKS (B-B) = 143.2 FT.
MEASURED DEPTH = 2.75 FT.



SITE NO. 71

BLACK RIVER

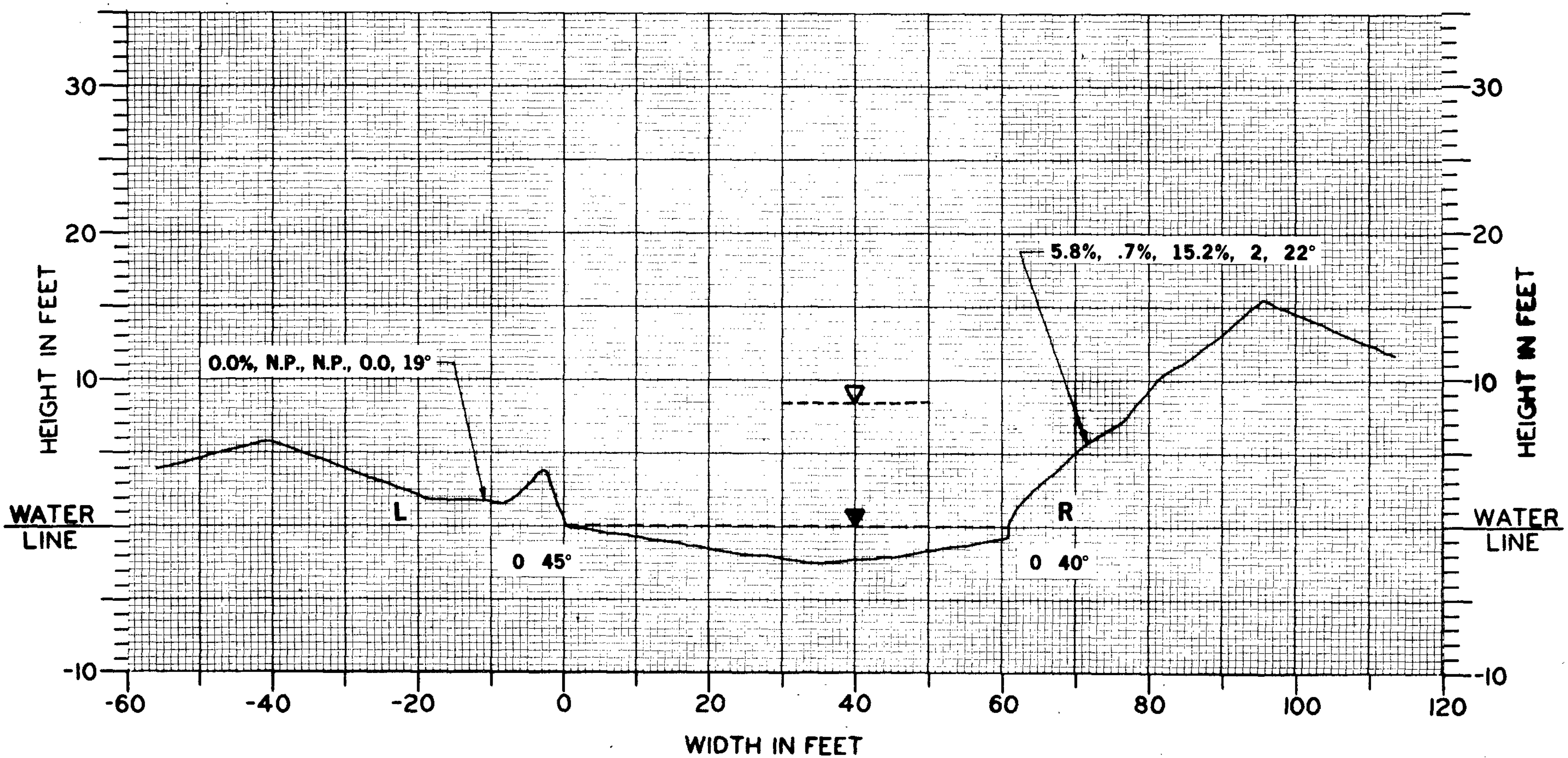
WIDTH OF STREAM (W-W) = 61.7 FT.
WIDTH OF BANKS (B-B) = 73.7 FT.
MEASURED DEPTH = 2.16 FT.



SITE NO. 72

BLACK RIVER

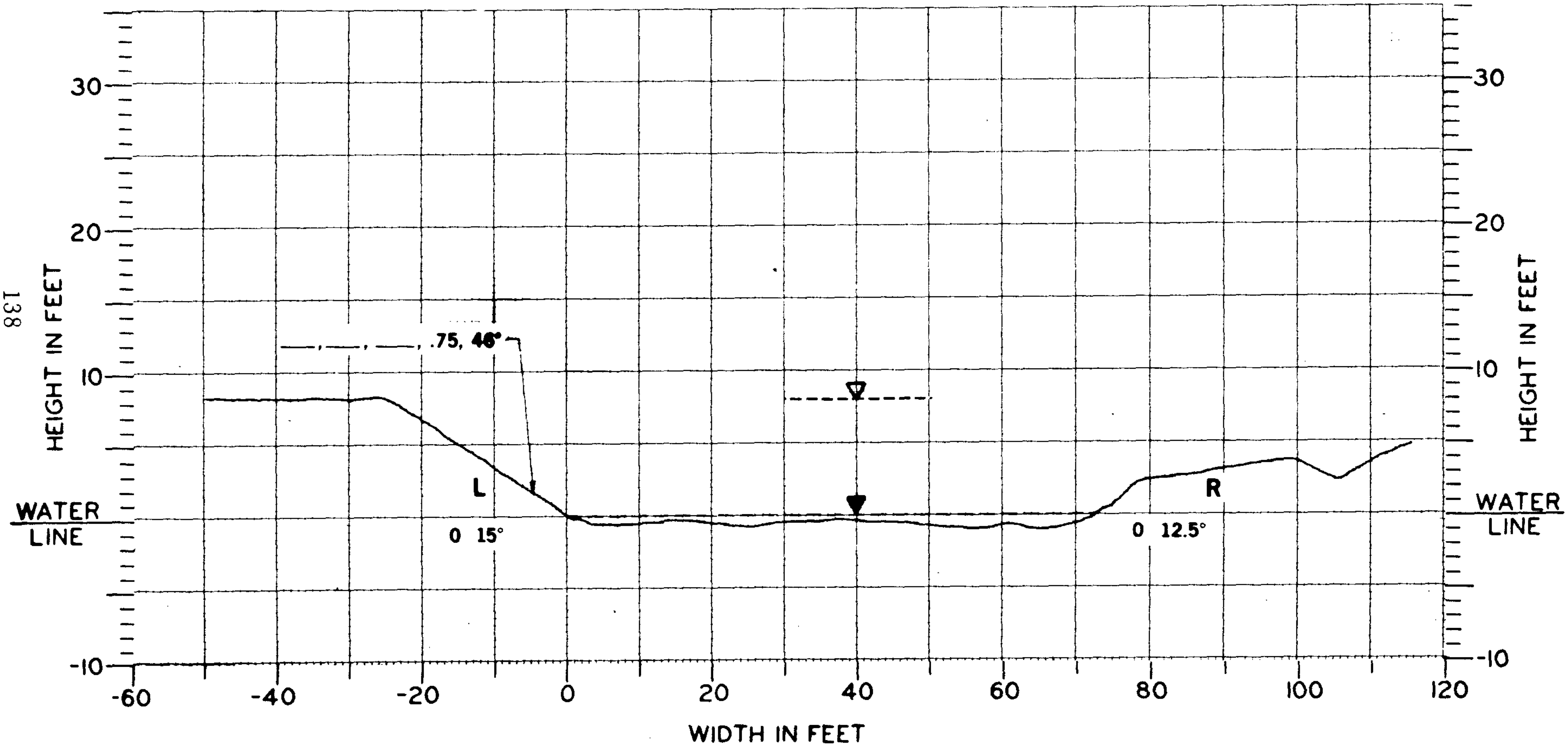
WIDTH OF STREAM (W-W) = 61 FT.
WIDTH OF BANKS (B-B) = 65.3 FT.
MEASURED DEPTH = 2.65 FT.



SITE NO. 73

BLACK RIVER

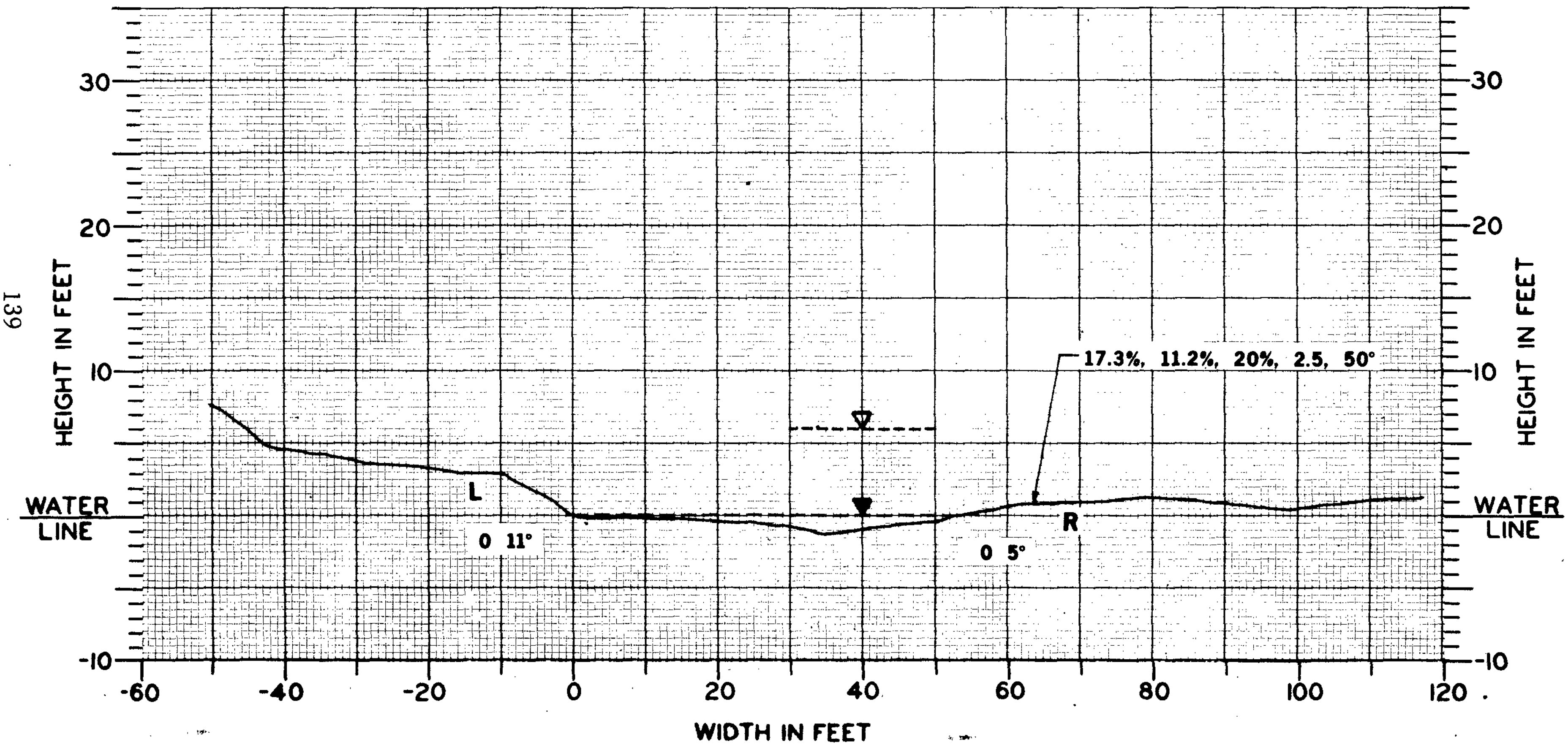
WIDTH OF STREAM (W-W) = 72.6 FT.
WIDTH OF BANKS (B-B) = 113.6 FT.
MEASURED DEPTH = 1.0 FT.



SITE NO. 74

BLACK RIVER

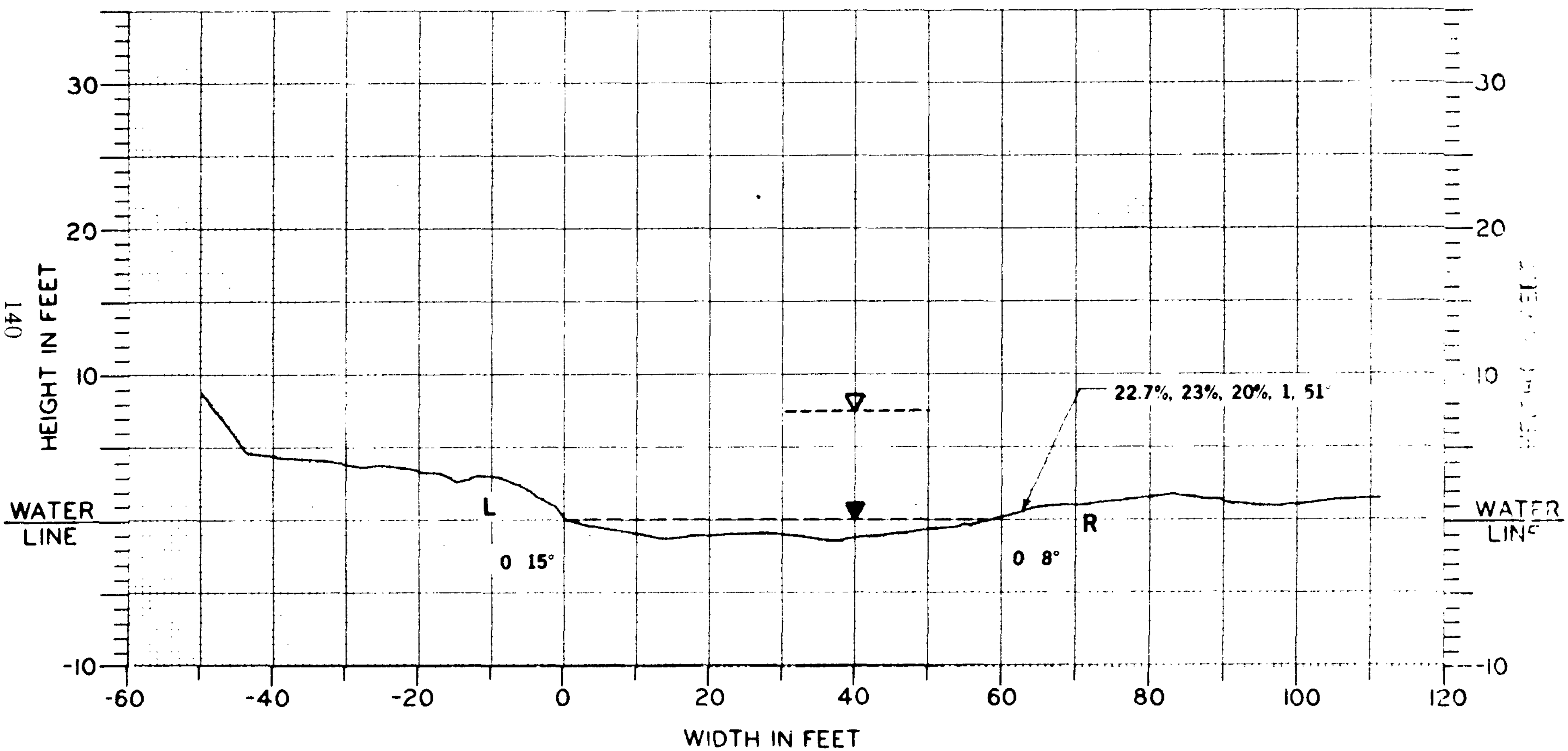
WIDTH OF STREAM (W-W) = 52.8 FT.
WIDTH OF BANKS (B-B) = 77.5 FT.
MEASURED DEPTH = 1.22 FT.



SITE NO. 75

BLACK RIVER

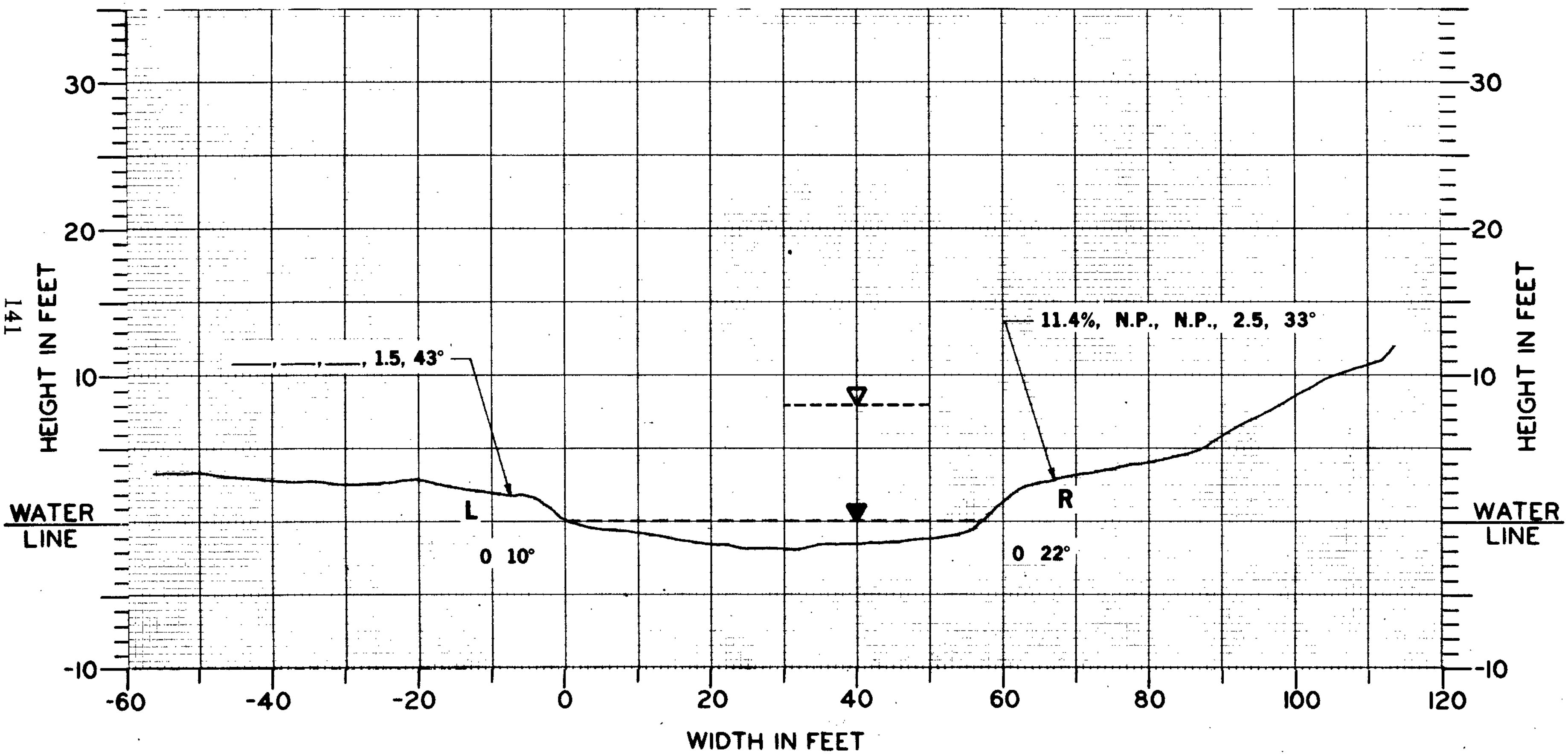
WIDTH OF STREAM (W-W) = 58.7 FT.
WIDTH OF BANKS (B-B) = 66.6 FT.
MEASURED DEPTH = 1.38 FT.



SITE NO. 76

BLACK RIVER

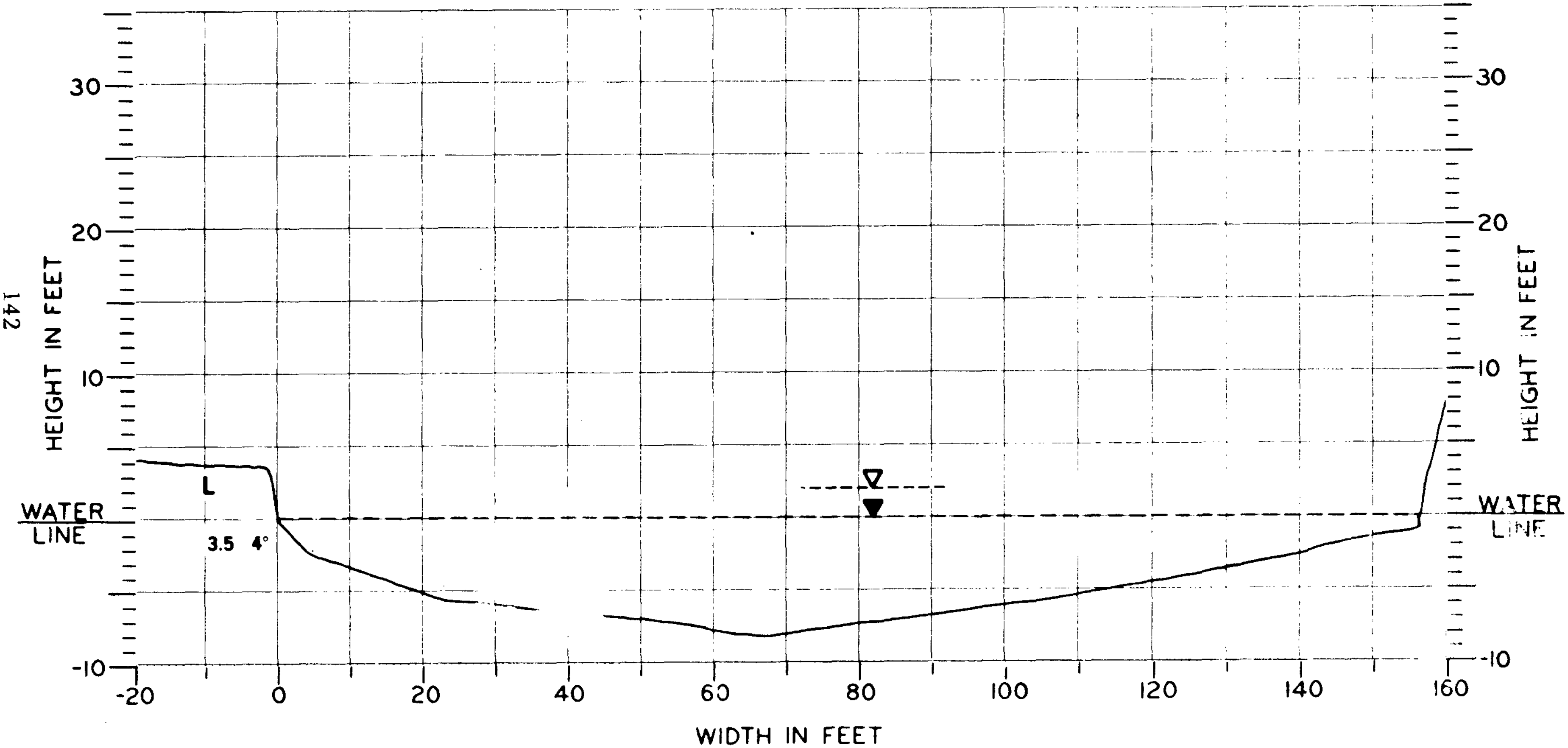
WIDTH OF STREAM (W-W) = 57.4 FT.
WIDTH OF BANKS (B-B) = 84.1 FT.
MEASURED DEPTH = 1.9 FT.



SITE NO. 77

BLACK RIVER

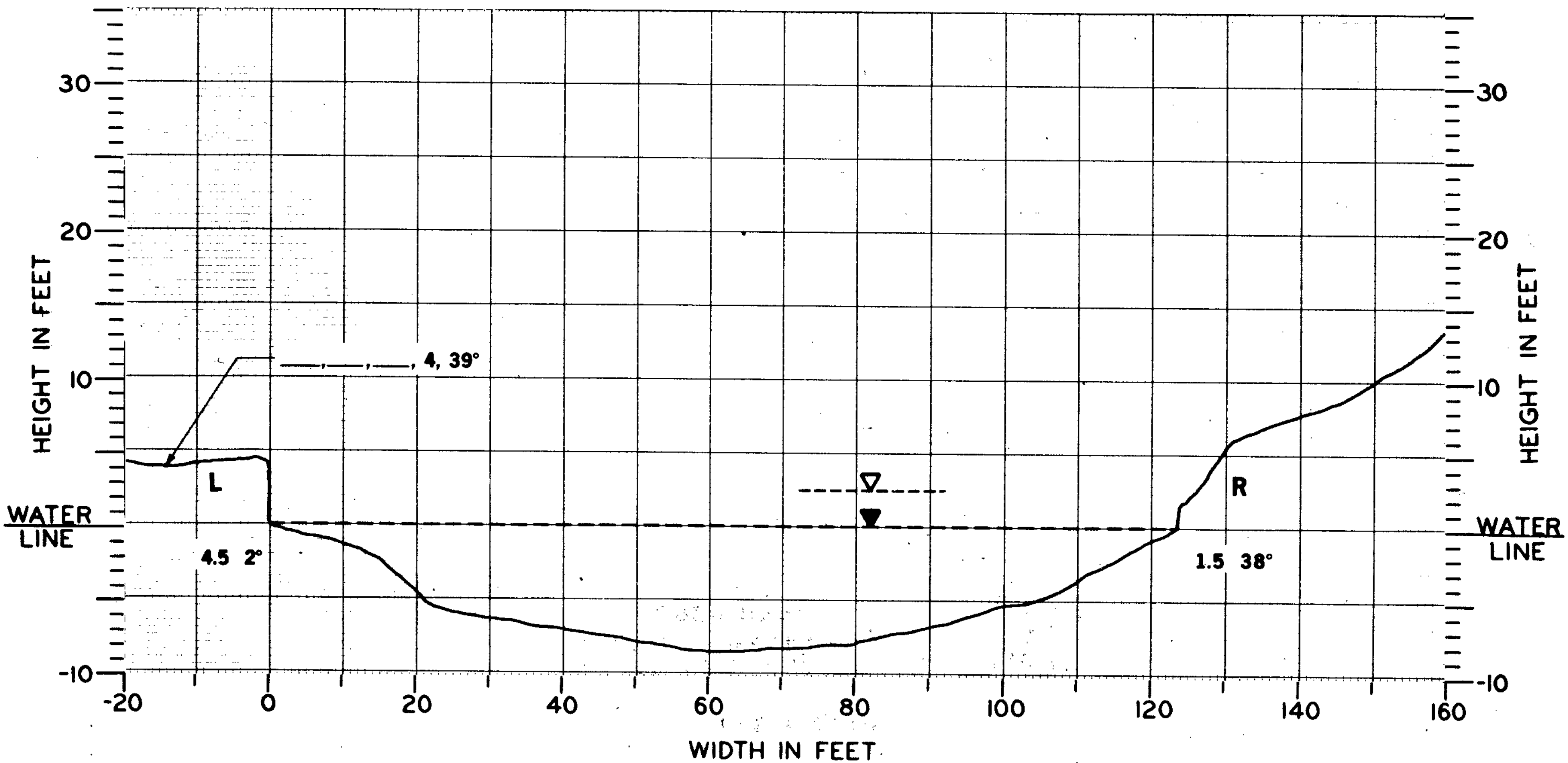
WIDTH OF STREAM (W-W) = 156.2 FT.
WIDTH OF BANKS (B-B) = 178.8 FT.
MEASURED DEPTH = 8.2 FT.



SITE NO. 78

BLACK RIVER

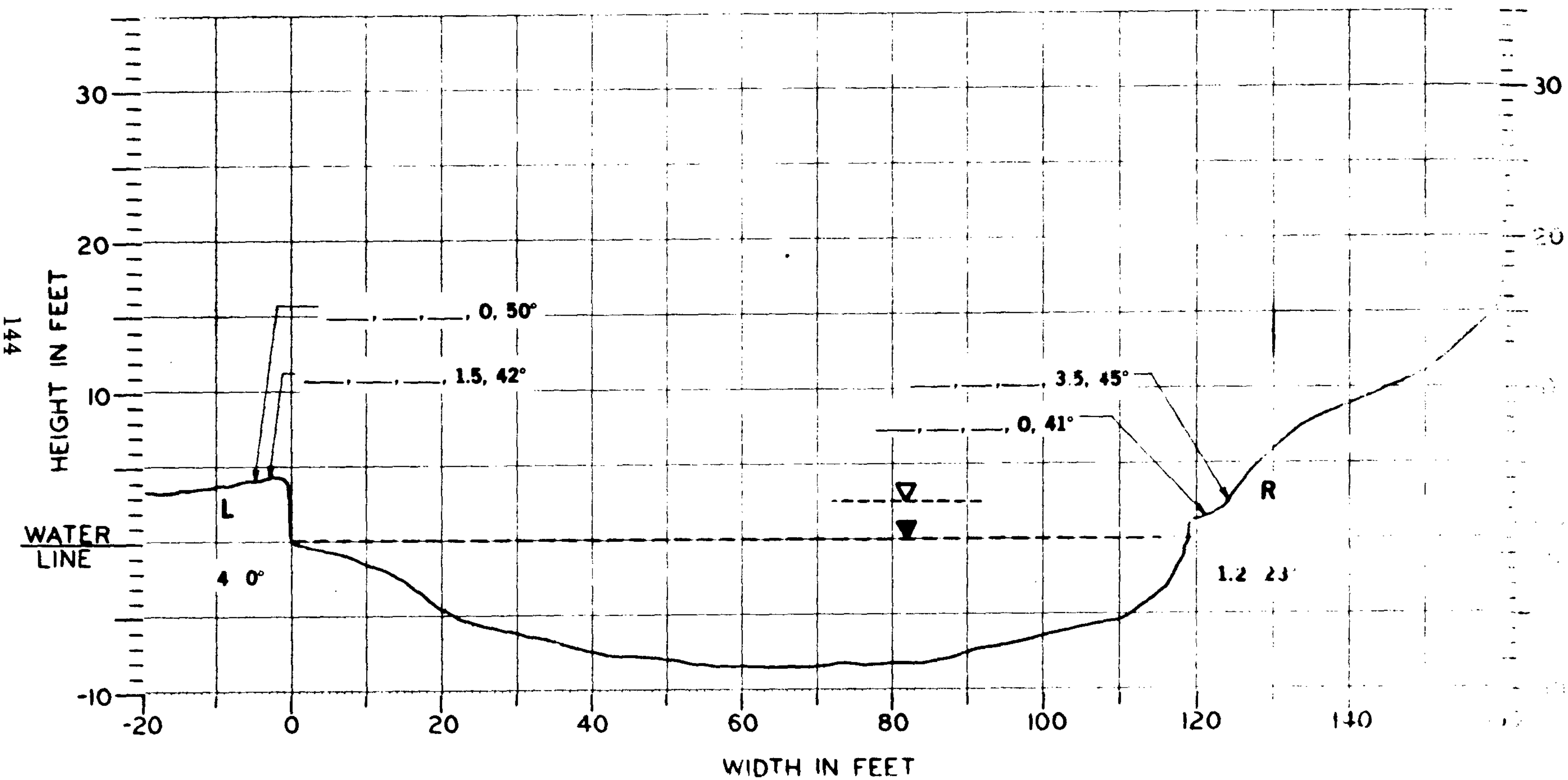
WIDTH OF STREAM (W-W) = 123.6 FT.
WIDTH OF BANKS (B-B) = 123.6 FT.
MEASURED DEPTH = 8.6 FT.



SITE NO. 79

BLACK RIVER

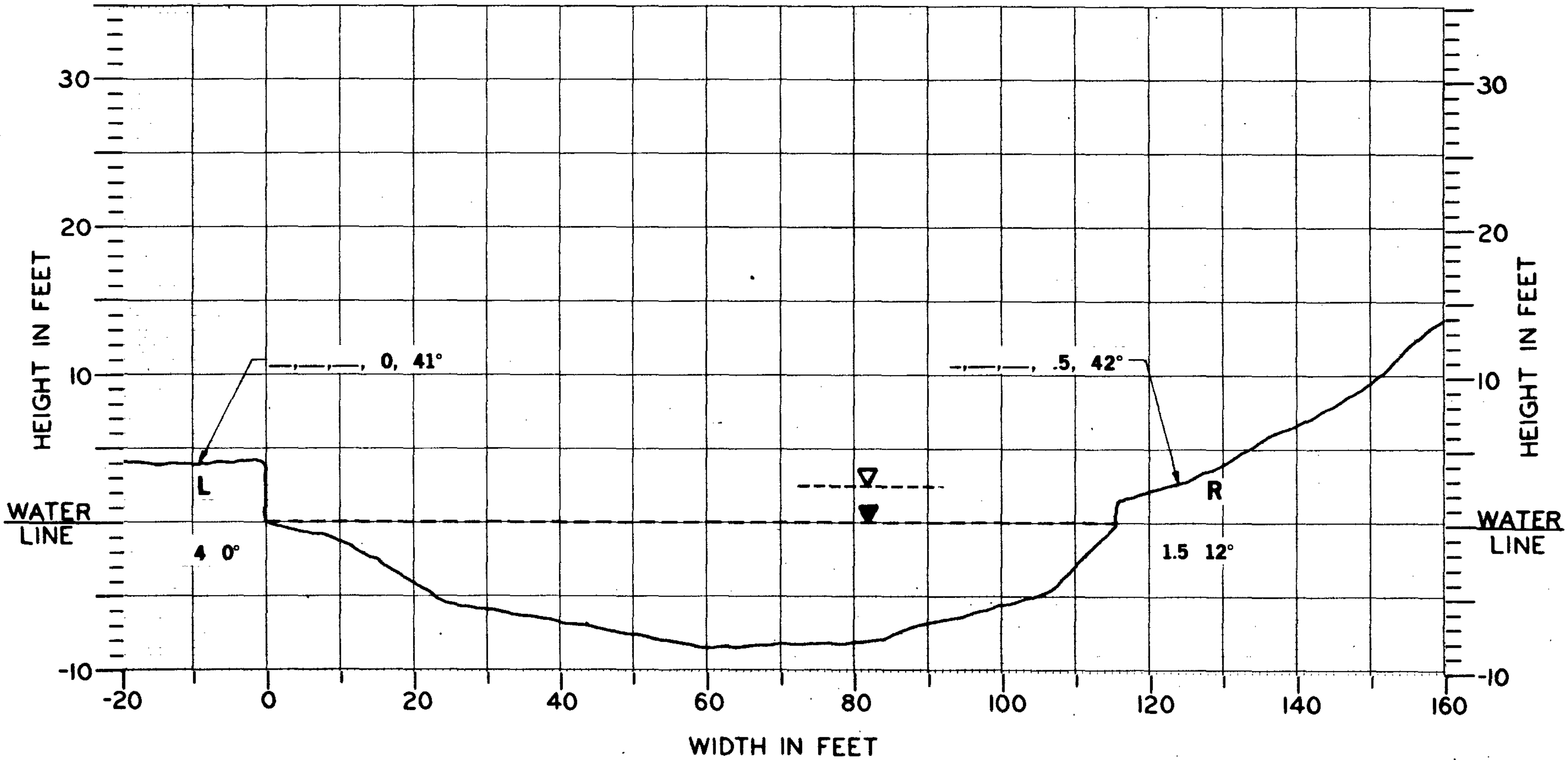
WIDTH OF STREAM (W-W) = 119 FT.
WIDTH OF BANKS (B-B) = 119 FT.
MEASURED DEPTH = 8.5 FT.



SITE NO. 80

BLACK RIVER

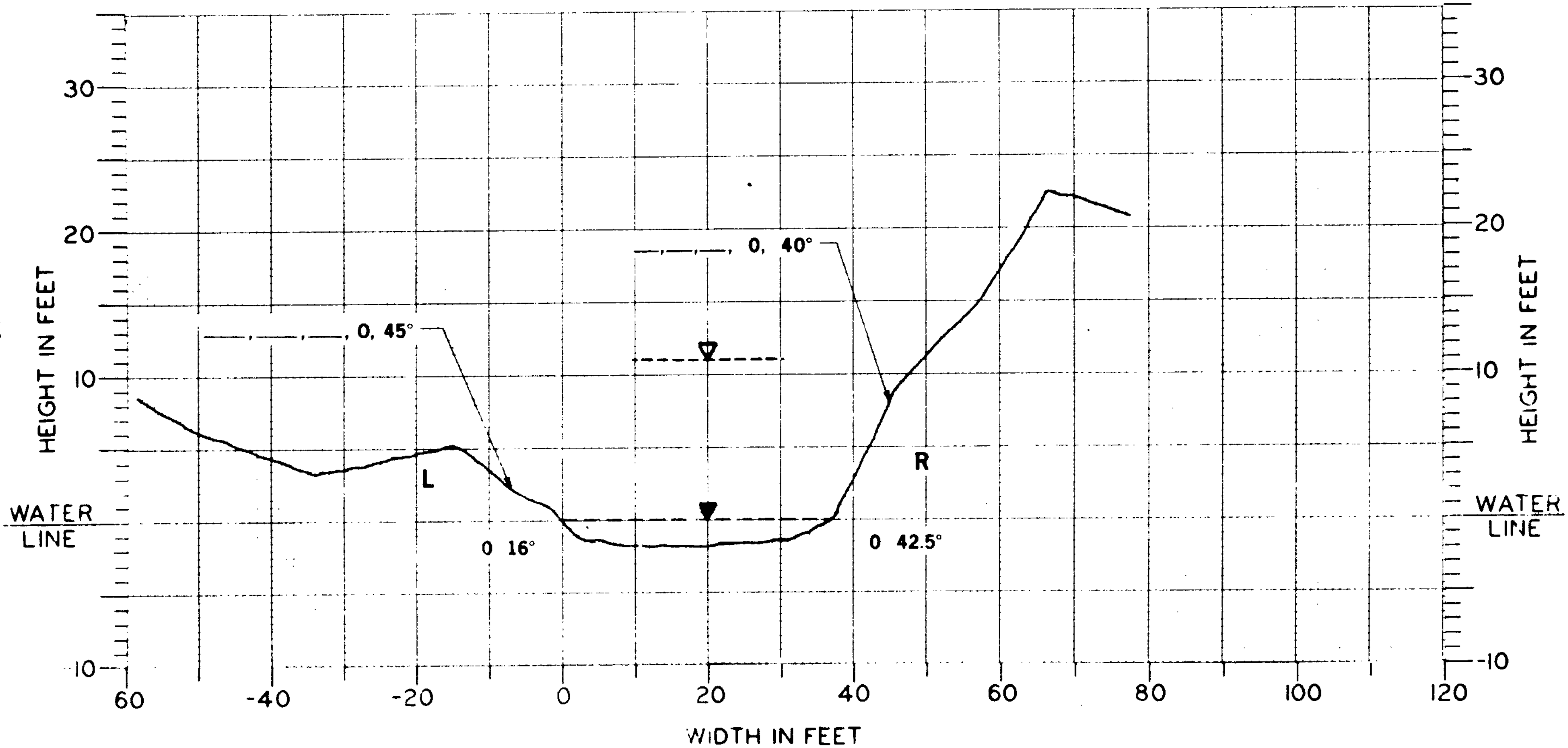
WIDTH OF STREAM (W-W) = 115.5 FT.
WIDTH OF BANKS (B-B) = 129.5 FT.
MEASURED DEPTH = 8.5 FT.



SITE NO. 81

BLACK RIVER

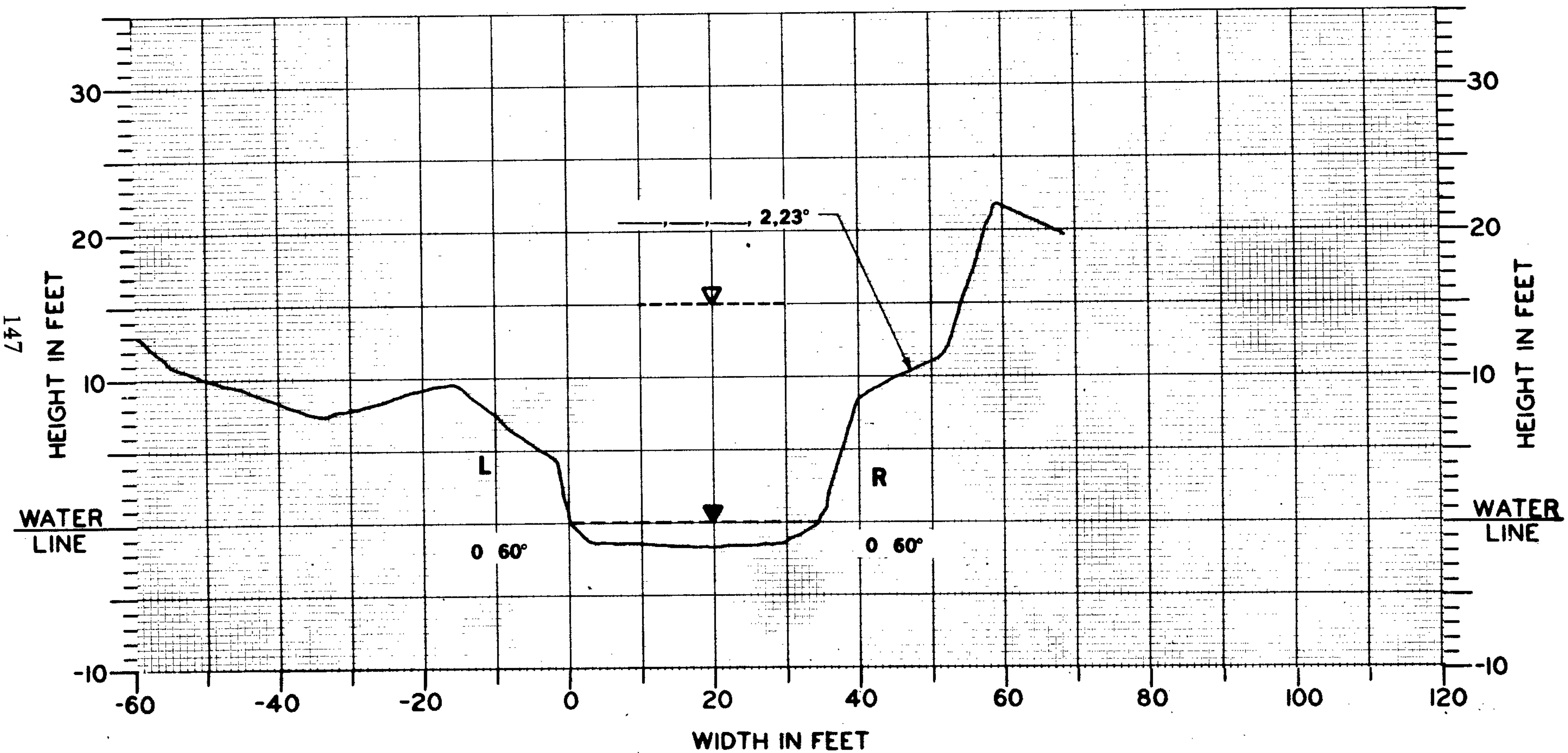
WIDTH OF STREAM (W-W) = 37.1 FT.
WIDTH OF BANKS (B-B) = 52.7 FT.
MEASURED DEPTH = 1.95 FT.



SITE NO. 82

BLACK RIVER

WIDTH OF STREAM (W-W) = 34.2 FT.
WIDTH OF BANKS (B-B) = 65.5 FT.
MEASURED DEPTH = 1.62 FT.



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13. ABSTRACT

A survey was made along the Black and the Huron Rivers in southern Michigan to determine the character and magnitude of the riverine environment. This was a pilot study to assess the feasibility of intensive riverine surveys, significant factors, and methods to collect the data. Eighty-two sites were surveyed.

Survey data concerning 1. cross-sections, 2, soil properties and strengths, 3, vegetation characteristics, 4, conditions along the channel bottom, is included in the report. Methods for gathering the data, types of data gathered, analysis, conclusions, and recommendations for future survey techniques are discussed.

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